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Railway Mechanical Engineer

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Passenger Car Terminal Competition

On page 57 of the February number we announced that we would give a prize of $35 for the best article and a second prize of $25 for the next best article on passenger car terminal methods or organization. The article is to be judged from a practical standpoint. Any other articles that are accepted for publication will be paid for at our regular rates. The passenger car terminal forms a most important link in the chain of facilities for the safe operation of passenger trains and caring for the comfort and convenience of the traveling public. There has been very little written on this subject, and we believe that a great deal can be brought out which will be of distinct benefit to car department officers and men throughout the country. It is not necessary for those taking part in the competition to discuss the subject as a whole, or to consider any particular phase of it. Anyone whose experience has been mainly along one special line is quite as likely to win the prize by dealing with that particular phase of the subject in a broad way as one who may endeavor to cover the entire terminal yard question. In order to qualify, the articles must be in our offices in the Woolworth Building, New York, on or before April 1, 1916.

Horizontal Sheathing on Box Cars

One of the first criticisms that was brought forth in arguments against the outside steel frame, horizontally sheathed box car was that it would be impossible to prevent water from entering the car through the joints of the horizontal sheathing. The promoters and others who favored this type of car have always held that this criticism is without foundation and that no such leakage occurs. This type of car has been built in such large numbers during the past few years that it has been generally supposed that the charge of leakage in this way has been amply disproved. It was therefore surprising to learn recently of well authenticated cases of leakage through the tongue-and-grooved joints of horizontally sheathed box cars to an extent sufficient to cause extensive damage to flour and similar shipments. Moreover it was found that it was not necessary that the water be driven against the side of the car with any force, the action of water running down the side of the car as in a gentle rain being sufficient, as the water passes through the joint apparently by some sort of capillary action. If this condition is general it is likely to seriously affect the future building of this type of car, and it would be interesting to know what the general experience has been of those roads operating cars of this type.

Increasing the Length of Locomotive Runs

A means for decreasing the total fuel consumption of road locomotives that has not been given the consideration it deserves by the railroads of this country is the practice of running the same locomotive over two successive divisions. Reports that have sometimes been printed regarding this practice show that it is thoroughly practical and that a substantial saving in fuel can be made. It has been reported that over 30 per cent of the fuel consumed by road locomotives is burned at the terminals. What better argument can be advanced for cutting out one of these terminal delays for any through locomotive run? Tests on the Lehigh Valley showed that by running a passenger train through from New York to Buffalo with one engine a saving of practically 50 per cent in the coal consumed by the engine was made. The Great Northern runs some of its engines over 400 miles without change. Other roads have also increased the length of their engine districts, and found it profitable from a fuel standpoint.

In some cases operating difficulties have arisen to the extent that this practice has been regarded as inexpedient. When this is the case, however, a very careful analysis should be made, for perhaps a change could be made in the operating conditions which would cost less than the amount saved in fuel by running the engine over two divisions.

What is Heat-treated Steel?

Special steels will undoubtedly be used in large quantities for locomotive parts within a comparatively short time; in fact, heat-treated steel and some alloy steels are being more generally used all the time. Unfortunately a great many railway blacksmiths have not been trained in the methods of handling such steels and they will require a considerable amount of education along these lines. With a view to bringing out the best practice in dealing with heat-treated steel, we will give a first prize of $35 and a second prize of $25 for the two best articles, judged from a practical standpoint, on "What heat-treated steel is and how it should be handled." The articles must be received in our offices in the Woolworth Building, New York, on or before May 1, 1916. For any articles which do not receive a prize but are deemed worthy of publication, we will pay our regular space rates. It is desired to bring out in this competition facts concerning heat-treated steel and its use which will be of direct value and assistance to smith shop foremen in their work. While a certain amount of theoretical discussion may be necessary, it should be confined as closely as possible to such essentials as directly affect practice. This is an opportunity for those who are familiar with the forging and heat-treating of this material to greatly assist those others who have as yet had no experience with heat-treated steel but who are likely to have at any time and therefore should be prepared for it.

The Reinforcing of Underframes

There are a great many wooden freight cars being equipped with steel reinforcements of one kind or another in the underframing. Some of these reinforcing structures are well designed, and so applied that they strengthen the old underframe and adequately protect the car from severe shocks; but there are some of them that are not reinforcements, but trouble makers. There is no use in applying to a wooden car two light steel sills inadequately

attached to the old underframe. Even if they are substantially connected to the body bolsters it has been found that instead of adding to the strength of the wooden center sills these light steel sills will buckle and spring away from the wood sills. Again when these light steel sills are used they are seldom supported properly at the end sill, with the result that in a very short time they begin to crack or bend at the body bolster and the outer end consequently drops so that the coupler is below the standard pulling height. When steel sills of this nature have been repaired because of the troubles indicated above the work is much more difficult and expensive than it would have been to repair the original wooden underframe. Experience has shown that the wooden underframe would have been almost, if not quite as strong without this so-called reinforcement. If our old freight equipment is to be made suitable for operation in present-day trains, the reinforcing structure for the underframe must be more reasonably designed and better applied than in a large number of cars that have been rebuilt in the past few years.

Design of New Equipment

In the designing of new equipment the mechanical engineer can be most ably assisted by the men who are to repair and maintain it after it has been built. On the Chicago, Rock Island & Pacific definite action is taken before the final drawings and specifications are submitted to the builders. If an entirely new design is planned the drawings are made in the mechanical engineer's office and sent to the mechanical superintendents of the various divisions who, with their subordinates, including the general foremen and inspectors, make a careful study of the design and either approve or recommend changes which would be desirable according to their experience. The plans are then returned with the criticisms and the matter considered in a staff meeting of the general mechanical officers. In the case of the contemplated purchase of cars from designs that have previously been used, the same procedure is followed and in this case the men, having actually handled the equipment, are in a position to state definitely just what changes should be made.

At the general meeting, if there should be a conflict of opinion the disputed points are thoroughly discussed and a vote taken as to which practice shall be followed. By this means it is possible to bring theory and practice together with the best possible results. When the equipment is placed in service the men on the firing line are extremely interested in its performance. They feel that they have had a hand in its design. They are constantly watching to see what can be improved so that they may make suggestions the next time they are called upon to pass on new equipment. They are not only educating themselves but giving the company the benefit of their experience. It is a plan that has worked out in a highly satisfactory manner and one that more closely knits the relationship of the repair and construction forces.

The Enginehouse Competition

On another page of this number will be found the prize article in the enginehouse competition which closed February 1. There were twelve articles received, all of which have sufficient merit to warrant our using them in whole or in part, but the judges considered that that by E. W. Smith was the one most worthy of the prize. The organization described by Mr. Smith is that for a very large enginehouse and it has been successfully used for some time at two large terminals, one handling freight locomotives and the other passenger. While it is not expected that everyone will agree with his ideas, there is no doubt that there are many features of the methods employed at these two terminals which would be of value if followed at other points. For instance, there might be mentioned the practice followed as regards inspectors. The lines of their work are laid down in such a way that there seems to be sufficient flexibility to the organization to insure the most efficient carrying out of both the inspection work and the light repair work. Mr. Smith's reasoning as outlined in the portion of the article dealing with discipline is also worthy of special consideration, one of the most important parts of this being the reference to a system of organization that provides each man with a day off during the week and at the same time a man who is thoroughly familiar with his work to take his place. One of the worst features of many enginehouse organizations is that if a man who has any special work assigned to him lays off, his work either has to be left undone or is done indifferently till his return. The practice outlined in the article follows the system which we have frequently advocated of having at least two men who are capable of taking charge of any particular line of work.

Organization and Low Maintenance Costs

The superintendent of motive power of a road that has been especially successful in securing low unit maintenance costs and a small number of engine failures was asked one day for the secret of this success. He disclaimed any credit for the good performance, passing all of it on to his subordinates, stating that they have all been with him on the road long enough to know that what he wants is *results*. They are given a free hand in their work and as much "red tape" as possible is eliminated. If they need more help or decide to discharge some, it is unnecessary for them to consult him. They are expected properly to maintain the equipment at the lowest possible cost in keeping with a high degree of efficiency. He stated further that he, personally, has so little work to do that he is almost ashamed to draw his salary!

This man has capitalized his personality and undoubtedly is worth more money than he is getting. He won the confidence of his men by treating them fairly; he won their respect by demanding results. He gets their co-operation by treating them as human beings, giving them all the right to their own opinions. "Frequently," he says, "we have heated discussions which to an outsider would appear as rank disruption, but we get all the arguments from which the final policy is determined. I would discharge a man who would agree with me against his honest convictions." Is it any wonder that that mechanical department succeeds? It is organized along human lines. The men are made to feel that they form an important part of the organization. It is a close organization—one large family; they are sure of fair treatment; they are contented. They make their efforts count and produce results.

Maintenance of Steel Cars

There has never been a more complete discussion of the problems involved in the use of steel cars than in the article written by M. K. Barnum and published elsewhere in this issue. Mr. Barnum has made a special study of this question and, from the experience gained from steel cars that have been in service for a number of years, has been able to present important facts regarding the life of this class of equipment and make valuable suggestions concerning its maintenance and repairs. The open steel freight cars, having been in more general use than any other type of steel car, present the greatest field for investigation. The lessons learned from them are, however, of value in solving the problems of all steel cars. When the steel cars were first thought of and actually built they were considered to be almost a panacea for all freight car troubles. By their use it was possible to increase the length of trains. Being built of steel they were expected to withstand the roughest kind of handling. Also their life was considered to be almost indefinite. As a result they were placed in service with an overestimated value of their usefulness. They were allowed to

run with but little thought regarding their maintenance. Experience has shown the fallacy of these ideas, and brings home to the owners the disappointing fact that the steel cars are not the "immortals" they were once supposed to be.

It is not intended to imply that the steel cars are a mistake or even an expensive luxury. They are a positive necessity on the modern railroad. They are needed, and do their part in reducing transportation expenses. The savings thus accomplished, however, must not be neutralized by the rapid depreciation of these cars due to the lack of proper maintenance. They must be protected from corrosion and they must be built so that the parts subjected to the severest service can be readily renewed. Mr. Barnum shows how steel bridges and locomotive tenders have been made to last for 25 or 50 years by keeping them well protected with paint. He presents photographs of the outside of gondola cars in a badly rusted condition from the lack of paint, and states that, owing to the almost impossible task of keeping the inside of these cars painted, the managements of some roads claim that it is a waste of money adequately to protect the outside. Whoever follows this practice is, in fact, burning the candle at both ends, for a steel plate which is subjected to corrosion on one side only, will last longer than if it is allowed to rust away on both sides. Nor are the sides the only parts of the car neglected. Illustrations used in Mr. Barnum's article show what is to be expected when the underframe is not properly protected from corrosion.

The statement is made by Mr. Barnum that some railway men claim that the best means of preserving the interior of the open steel cars is to keep them in service. There are times, however, when it is necessary to store these cars. Why not thoroughly clean them and give them a coat of the "No. 4 Mixture" mentioned by Mr. Barnum as being recommended by the Master Car Builders' Association? The steel cars are with us to stay, and they must be maintained. Their first cost is greater and their maintenance cost is greater than those of the old wooden cars, but they earn more. They will produce even greater returns if they are given proper care.

Road Conditions and Locomotive Types

We were recently asked what we had done to popularize the 2-10-2 type locomotive. We doubt very much whether it would be advisable to try to popularize any type of locomotive. Experience has shown that when a new type of locomotive is introduced it is more than likely to be ordered in a great many cases more because it is "popular" than because it is the most suitable type for the service required. We are not trying to detract from the value of the work that is being done by locomotives of the Santa Fe type on several roads, nor is it the intention to urge the general adoption of some other type instead. Locomotives of this type are giving excellent results in a number of cases on roads where the character of the traffic and the road conditions make them admirably suited for what is required, but because of this success there appears to be a very general idea that multiple-axle locomotives are "in style" and therefore should be ordered when new power is required, regardless of whether conditions warrant it or not. There has been too much "popularizing" of locomotive types in the history of American railroading and it is high time that railway men realize that economy and efficiency in train operation require the employment of locomotive types which are suited to the conditions which are to be met.

Of course, the final decision may be that the type best suited to the work is the 2-10-2 or a similar type. As stated above, we have no fault to find with a decision of this character. There may even be cases where the condition of a road's finances would justify, from the standpoint of economy, the purchase of multiple-axle locomotives of comparatively light weight per axle rather than to go to the expense of rebuilding track and bridges so that heavier axle loads could be used with smaller locomotives in increasing the average train load. The point we have in mind does not have reference to such conditions as these but to the indiscriminate purchase of a popular type of locomotive simply because it has proved efficient on another road where the physical characteristics and the traffic conditions may be quite different.

There is another feature connected with the purchase of large locomotives which even some of the larger roads have not considered any too carefully. The cost of locomotive repairs is increasing; this seems quite natural when we consider the increases in wages and the increase in the size of locomotives during the past few years, but there are many instances where large locomotives have been purchased with little or no consideration being given to the facilities available for repairing them, and without adequate shop and enginehouse facilities the cost of maintenance of the large locomotive is going to be greater than it would be if proper facilities were provided. We are all familiar with the inadequate roundhouse which necessitates the leaving open of the doors on stalls occupied by modern engines because of 10 or 15 feet of the tender being still outside the house when the locomotive is under the smoke jack. The repair facilities of such an enginehouse are invariably on a par with this condition, and when one considers the cost of removing and repairing heavy parts of a modern locomotive under such conditions, the feeling is one of amazement at the shortsightedness of a policy that provides heavy locomotives without any consideration being given to the repair facilities. The roundhouse is not the only place that has been outgrown by the locomotive. There are many roads which are no better off as regards main repair shops. Efficient, economical repair work cannot be done on a modern locomotive by machine tool equipment that was intended for the repairing of the American and Mogul type engines of 25 or 30 years ago.

We have endeavored in the foregoing to lay special stress on the importance of two points: First—Consider traffic and physical conditions carefully and choose a type of locomotive that is suited to them. Second—Be sure that the shop and terminal facilities are capable of economically repairing and handling the engines after they are purchased.

NEW BOOKS

Proceedings of the Twenty-third Annual Convention of the International Railway Master Blacksmiths' Association. Size, 6 in. by 8½ in., 226 pages. Bound in cloth. Published by the Association, A. L. Woodworth, Secretary, Lima, Ohio.

This volume contains a complete account of the proceedings of the last annual convention of the International Railway Master Blacksmiths' Association, which was held at the Hotel Walton, Philadelphia, Pa., August 17-19, 1915. Among the subjects discussed were flue welding, frog, switch and crossing work, carbon and high-speed steel for tools, tools and formers, reclaiming scrap, and shop kinks. The volume contains a fund of information on these subjects which will be found of value to many blacksmith foremen.

Oxy-Acetylene Welding and Cutting, Electric and Thermit Welding.—By Harold P. Manly. Bound in cloth. 209 pages, 4¼ in. by 6¼ in. Illustrated. Published by Frederick J. Drake & Company, Chicago.

This book should prove of value to anyone concerned in metal working. Its size has been kept small but the range of subjects and the details covered is very complete. The chapters include discussions of the heat treatment of metals; welding materials; acetylene generators; welding instruments and a general discussion of the practice in both oxy-acetylene and electric welding. There are also chapters devoted to hand forging and welding as well as soldering, brazing and thermit welding. The illustrations are particularly clear and show the various types of equipment in considerable detail.

PULVERIZED FUEL FOR LOCOMOTIVES*

The Economic Advantages of Pulverized Fuel; Essential Features of the Locomotive Equipment

BY J. E. MUHLFELD
President, Locomotive Pulverized Fuel Company

For the purpose of quickly conveying to you my reasons for believing that the burning of solid fuels in a pulverized form is the most promising solution of our fuel problems, and that it will become the generally adopted method for generating power in steam locomotives, the following facts and conclusions are set forth:

First.—The present annual consumption in the United States of about 7,000,000 tons of solid fuel in pulverized form, in industrial kilns and furnaces, has demonstrated the effectiveness and economy of this method of combustion.

Second.—The expenditure for locomotive fuel is, next to labor the largest single item of cost in steam railway operation. The Interstate Commerce Commission reports that this expense for the fiscal year ending June 30, 1915, was $249,507,624, or about 23 per cent of the transportation expense of 242,657 operated miles of steam railways in the United States.

Third.—The necessity for conserving the limited supply of oil in the rapidly exhausting fields, for other than locomotive purposes, will shortly eliminate it from railway motive power use.

Fourth.—Present requirements for reliable and flexible motive power of relatively low first cost, and expense for fixed charge, maintenance and operation, precludes the use of internal combustion, compressed air, hot water, storage battery, and electric locomotives dependent upon an outside source of power, for the general movement of heavy traffic.

Fifth.—The quantity of steam used by the modern locomotive necessitates high rates of evaporation, and this can only be obtained economically by some means for burning solid fuel other than on grates, in order to reduce the waste of coal containing a large percentage of dust and that from imperfect combustion, to eliminate fire hazards, to conserve cylinder tractive efforts and to improve the thermal efficiency of the locomotive as a whole.

Sixth.—Shallower seams of coal; mechanical and powder methods of mining; greater security demanded for labor; the high cost for developing, tunneling, timbering, pumping, ventilating and inspecting mines; scarcity of, and higher wages for labor, and more rigid legislative rules and regulations will rapidly increase the cost for solid fuels.

Seventh.—Proper co-operation between the railways and the mine operators will necessitate that the former shall make use of the constantly increasing percentage of dust, slack, screenings, and other small sizes of gas, soft and anthracite coals, as well as of coke breese, lignite and peat which cannot now be effectively or economically burned on grates in locomotives.

Eighth.—Steam locomotives must be equipped to more nearly approximate the electric locomotives as regards the elimination of smoke, soot, cinders and sparks; reduction of noise, time for despatching at terminals, and stand-by losses, and to increase the daily mileage by producing longer runs and more nearly continuous service between general repair periods.

Ninth.—Labor of a higher average standard should be induced to enter the service as firemen by reducing the arduous work now required to fire modern steam locomotives of great power.

Tenth.—The future steam locomotive will be required to produce the maximum hauling capacity per unit of total weight, at the minimum cost per pound of drawbar pull, and with the least liability for mechanical delay.

These conditions as outlined can generally be met through the use of pulverized fuel. Its use offers opportunity for even greater accomplishment in the steam railway field than has been obtained through its use in cement kilns and metallurgical furnaces. A saving of from 15 to 25 per cent in coal of equivalent heat value fired, results from its use as compared with the hand firing of coarse coal on grates. As pulverized fuel may run as high as 10 per cent in sulphur and 35 per cent in ash and still produce maximum steaming capacity, and as otherwise unsuitable and unsalable or refuse grades of fuel may be utilized, the saving in first cost per unit of heat will be a considerable additional item. The most severe test* that has yet been made was with some semi-bituminous coal from Brazil, South America, analyzing when pulverized:

Moisture	from 2 per cent	to 8 per cent
Volatile	from 14 per cent	to 28 per cent
Fixed carbon	from 58 per cent	to 34 per cent
Ash	from 26 per cent	to 30 per cent

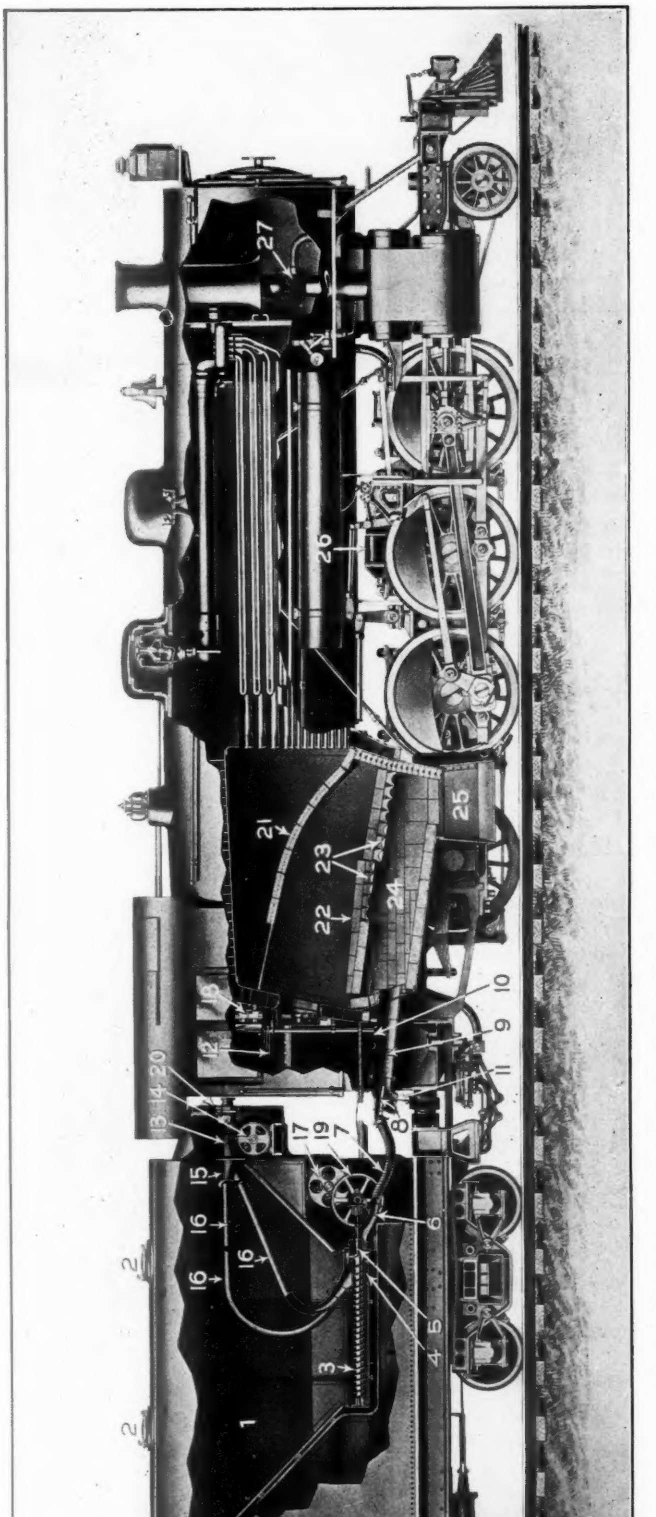
The sulphur averaged from 3 per cent to 9 per cent and the heating value from 10,900 B. t. u. to 8,800 B. t. u. No difficulty whatever obtained in maintaining maximum boiler pressure when working the locomotive with this fuel under the most severe operating conditions.

The use of pulverized fuel enables firebox temperatures and sustained boiler capacities to be attained equivalent to and exceeding those obtainable with crude or fuel oil. It eliminates waste products of combustion and fire hazards, and permits the enlargement of exhaust steam passages, thus producing increased efficiency of the cylinders. Pulverization permits the use of such fuel as cannot readily be disposed of by mine operators in the commercial trade, and provides for the utilization of existing refuse, and of lignite and peat. It renders possible the elimination of smoke, soot, cinders and sparks, and increases the time available for transportation use. It dispenses with the necessity for grates, ashpans and trailing trucks, thereby increasing the percentage of total locomotive weight available for the development of drawbar pull.

Commencing with Richard Trevithick's locomotive, which was built in 1803, and was the first to actually perform transportation service, the general practice has been to burn wood, coal and other solid fuels in locomotive fireboxes on grates. However, during the past twenty-five years the continued advance in locomotive tractive effort has so increased the required rate of combustion that the quantity of fuel now used per unit of work performed is far beyond what a more effective means will produce. While great progress has been made in the superheating and use of the steam, the principal improvements that have been perfected in steam generation have been through the enlargement of heating surfaces, better circulation of water, regulation of air admission and the use of fire-brick arches. The locomotive boiler is responsible for, and involves the greatest proportion of inspection, cleaning, maintenance, liability for damage, and expense that obtains in the operation of steam railway motive power, but it has probably received the least consideration as regards improve-

*From a paper presented before the New York Railroad Club, February 18, 1916.

*For a discussion of the results of tests with pulverized fuel in locomotive service see the *Railway Age Gazette, Mechanical Edition* for May, 1915, page 213.



Locomotive Equipment for Burning Pulverized Fuel—See Table for Names of Parts

ment in its general efficiency. Today it is subjected to the most criticism from the general public as the result of the smoke, soot, cinders, sparks, ashes and noise that it produces.

Experimenting with coal dust for fuel dates as far back as 1818, although its actual industrial application in the United States did not begin until 1895, when the advance in the price of fuel oil led to its use in cement plants. The Manhattan Elevated Railroad in New York City made some experiments with the use of coal dust in one of its locomotives about fifteen years ago, the pulverizing of the fuel and the discharge of air and fuel into the firebox being accomplished by the use of a combined pulverizer, blower and steam turbine located on the locomotive. However, in this case the cylinder exhaust was not used to produce boiler draft, the coal dust was relatively coarse and no provision was made for precipitating and cooling the furnace slag, all of which no doubt contributed to the disuse of the equipment. The Swedish government railways have also done some experimental work in the burning of peat and coal powder in small steam locomotive boilers during the past few years, the fuel being prepared before supplying to the locomotive tender. In this case the powder is blown into the furnace by steam, and the firebox brick work is very complicated.

The first steam railway locomotive of any considerable size to be fitted up in the United States or Canada and so far as is known, in the world, with a successful self-con-

Names of Parts of Pulverized Fuel Equipment

1. Enclosed fuel container.
2. Fuel supply inlets and covers.
3. Fuel conveyor.
4. Fuel and pressure air feeder.
5. Fuel and pressure air commingler.
6. Fuel and pressure air outlet.
7. Fuel and pressure air flexible conduit.
8. Fuel and pressure air nozzle.
9. Fuel and air mixer.
10. Firing up opening.
11. Induced air inlet diameter.
12. Control for induced air inlet damper.
13. Pressure blower.
14. Steam turbine or motor for pressure blower.
15. Pressure blower manifold.
16. Pressure blower conduits.
17. Steam turbine or motor for fuel conveyor, feeder and commingler.
18. Control for steam turbine or motor for fuel conveyor, feeder and commingler.
19. Operating gear, shaft and clutches for fuel conveyor, feeder and commingler.
20. Switchboard (when electrical equipment is specified).
21. Brick arch.
22. Primary arch.
23. Auxiliary air inlets.
24. Combustion furnace.
25. Self-clearing air cooled slag pan.
26. Turbo-generator (when electrical equipment is specified).
27. Combination engine and turbo-generator exhaust nozzle and stack blower.

tained equipment for the burning of pulverized fuel in suspension, was a ten-wheel type on the New York Central. This locomotive has 22-in. by 26-in. cylinders, 69-in. diam. drivers, 200-lb. boiler pressure, 55 sq. ft. grate area, 2,649 sq. ft. heating surface, and has a tractive effort of 31,000 lb. It is equipped with a Schmidt superheater and Walschaert valve gear and was first converted into a pulverized fuel burner during the early part of 1914. Since the development of that application another similar installation has been made on a Chicago & North Western existing Atlantic type locomotive, and also on a new Consolidation type locomotive recently built for the Delaware & Hudson at the Schenectady works of the American Locomotive Company. This locomotive is probably the largest of its type in the world, as it has 63-in. drivers and about 63,000 lb. tractive effort, having been designed for combination fast and tonnage freight service.

This development has now passed the experimental stage, and arrangements have been made for proceeding with commercial applications as rapidly as the equipment can be produced. The general features of the equipment are shown in the illustrations and the method of introducing the fuel and air into the firebox will be understood from a study of the

names of the parts and the reference numbers on the sectional view of the equipment.

In the development of this apparatus the purpose has been to produce an equipment that will be readily applicable to either new or existing steam locomotives of standard designs; to standardize the various details and make them interchangeable for the different types and sizes of locomotives; to eliminate complicated mechanism for conveying fuel from the tender to the engine, and remove all special apparatus except fuel and air supply control levers, from the cab, and to insure positive control over the fuel feed, in order to quickly meet all conditions of road or terminal operation, and to provide for quick firing up. The entire regulation of combustion is effected through three hand control levers in the cab, i. e., fuel feed, air supply, and induced draft, the latter for use when the locomotive is not using steam. A refractory furnace is provided and so arranged that it insures ready accessibility to all parts of the firebox for inspection and maintenance. The fuel is carried in an enclosed container to insure a supply of dry fuel under all conditions of weather. The burning and storage equipment is designed to be readily convertible for the use of fuel oil.

In the application of the equipment to existing types of steam locomotives the diaphragm, table and deflector plates, nettings, hand holes and cinder hopper are removed from the smoke box and the exhaust nozzle opening is enlarged. The grates, ashpan, fire doors and operating gear are removed from the firebox, and a fire-brick lined firepan, slag-pan and primary arch, together with the fuel and air mixers and nozzles, are installed. The usual arch tubes and brick arch are utilized. In the cab the fire door is replaced with a furnace door and the fuel and air supply regulating levers are installed. The tender equipment includes the enclosed fuel container and the apparatus for feeding, mixing and discharging the fuel and air, together with the steam turbine or motor operating mechanism. The engine and tender connections consist of one or more hose which connect the fuel and pressure air outlets on the tender to the nozzles on the engine. Flexible metallic conduits are used to convey the fan and fuel feeding motive power.

For firing up a locomotive the usual steam blower is turned on in the stack, a piece of lighted waste is then entered through the firebox door opening and placed on the furnace floor, just ahead of the primary arch, after which the pressure fan and one of the fuel and pressure air feeders are started. From 45 to 60 minutes is ordinarily sufficient to get up 200 lb. steam pressure from boiler water at 40 deg. Fahrenheit.

The prepared fuel, having been supplied to the enclosed fuel tank, gravitates to the conveyor screws, which carry it to the fuel pressure air feeders, where it is thoroughly commingled with and carried by the pressure air through the connecting hose to the fuel and pressure air nozzles and blown into the fuel and air mixers. Additional induced air is supplied in the fuel and air mixers, and this mixture, now in combustible form, is induced into the furnace by the smokebox draft. The flame produced at the time the combustible mixture enters the furnace obtains its average maximum temperature, from 2,500 to 2,900 deg. F., at the forward combustion zone under the main arch, and at this point auxiliary air is induced by the smoke box draft to finally complete the combustion process. The uniformity with which locomotives can be fired, is indicated by the fact that the regularly assigned firemen can maintain the steam within a variation of two pounds of the maximum allowable pressure, without popping off. As each of the fuel and pressure air feeders has a range in capacity of from 500 to 4,000 lb. of pulverized fuel per hour, and as from one to five of these may easily be applied to the ordinary locomotive tender, there is no difficulty in meeting any desired boiler and superheater capacity.

The smokebox gas analysis will average between 13 and 14 per cent of CO_2, when coal is fired at the rate of 3,000 lb. per hour, between 14 and 15 per cent at the rate of 3,500 lb. per hour and between 15 and 16 per cent at the rate of 4,000 lb. per hour, so that as the rate of combustion increases, there is no falling off in the efficiency, as obtains when coarse coal is fired on grates. The waste of fuel from the stack where coal having a large percentage of dust and slack is used, the lowering of the firebox temperature and draft, due to opening the fire door and the resultant variation in steaming and general results under high rates of burning fuel on grates where all of the foregoing factors are involved, are eliminated.

The liquid ash runs down the underside of the main arch and the front and sides of the forward combustion zone of the furnace and is precipitated into the self-clearing slag-pan, where it accumulates and is air-cooled and solidified into a button of slag which can be dumped by opening the drop bottom doors.

As in the case of all mediums for producing mechanical power that are now used to bring about the most advanced and progressive results, such as naphtha, gasolene, kerosene, crude and fuel oils, compressed air, storage batteries and electricity, there is a certain element of danger in the use of pulverized fuel that does not obtain with the more ineffective coarse coal. However, there are now certain established rules and regulations governing the manufacture, storage, handling and use of pulverized fuel, which make it comparatively easy to avoid trouble, this being confirmed by the records of the industrial plant operations where ordinary care is exercised.

As in the case of electric locomotives, but little actual operating data is as yet available. The first complete installations of fuel drying and pulverizing plants and locomotive coaling stations, in combination with locomotives equipped for burning pulverized fuel, will be made by the Delaware and Hudson and the Missouri, Kansas and Texas, and these are not yet ready for operation. The locomotives so far equipped on other railways are still depending upon outside or inadequately equipped sources for their supply of pulverized fuel, which makes the handling somewhat difficult. However, in the locomotive operation to date, it has been definitely demonstrated by the results obtained in road passenger and freight service, that the facts and conclusions previously set forth are fully justified.

DISCUSSION

M. C. M. Hatch, Superintendent of Fuel Service, Delaware, Lackawanna & Western.—The railroad coal supply of this country now costs a great deal of money, and prices, as well as we may predict, will rise. We cannot, on grate equipped engines, use with satisfaction poorer grades of fuel than we now use. Our fuel charges are bound to go up unless some method other than that now generally used is developed. Pulverized fuel seems to offer the best solution, so far as can now be seen; oil is prohibitive in cost, except in a few parts of the country. In our mining districts are many thousands of tons of refuse, rejected as unsuitable for fuel but still containing much heat value. Endeavors to utilize this refuse in the form of briquettes have been made but with questionable results, at least in locomotive service. Pulverized fuel may prove an outlet for this waste material.

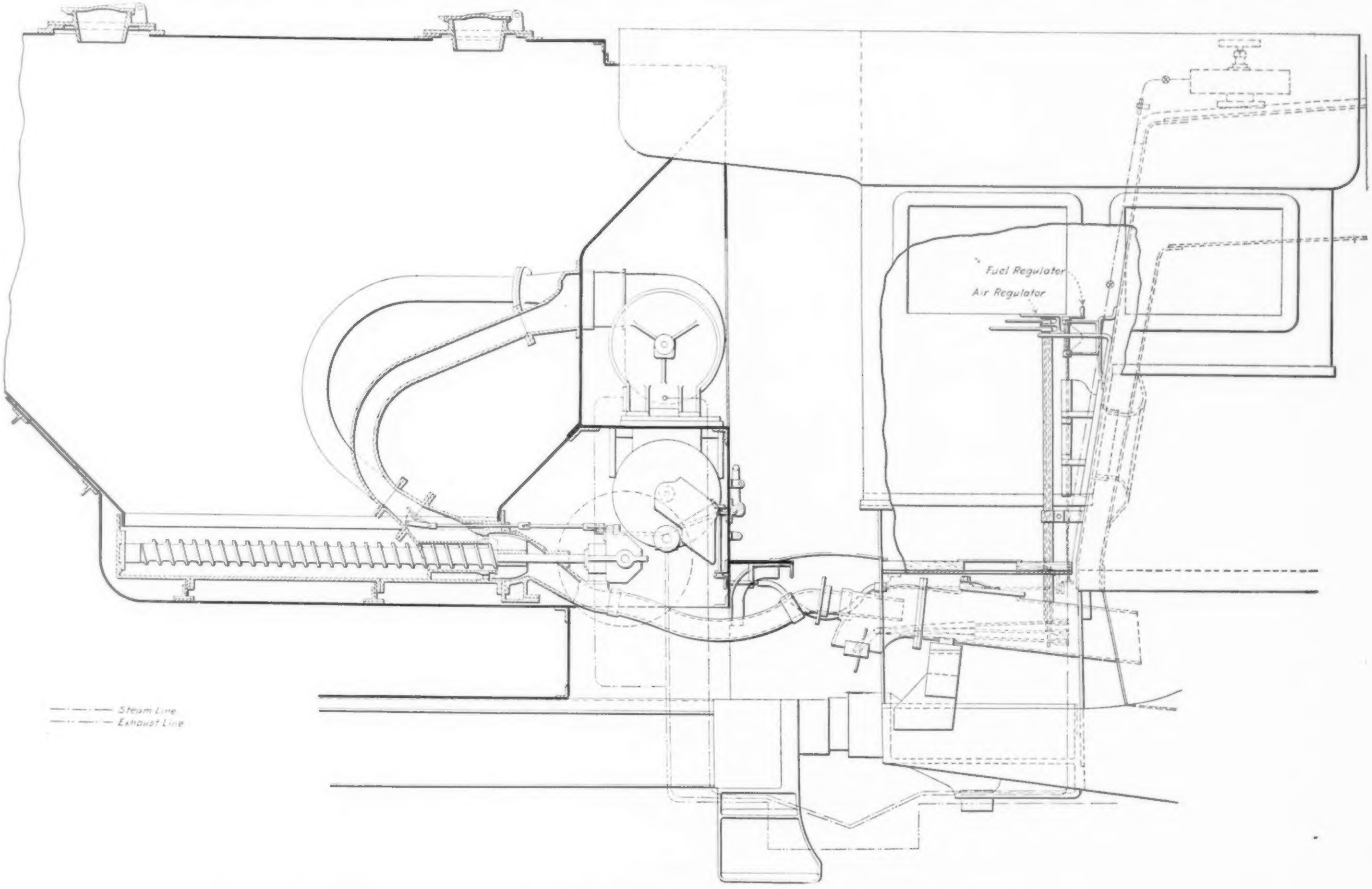
"Stand-by" losses of all kinds aggregate about 25 per cent of the total fuel consumed. If these can be reduced considerable savings will result. Engine divisions are restricted in length by the distance fires can be run satisfactorily. If we can lengthen them or increase the percentage of time during which an engine can be kept in actual service, our charges will be decreased. Flexibility in steam making should be attained to meet all operating requirements. If we can have this our service will be improved. We are trying as best we may to meet these conditions, but there are, at present, limits beyond which we cannot go, and the use of pulverized fuel may prove to be the solution of these difficulties.

My experience with oil burning locomotives has shown that it is not practicable to run a much larger nozzle when using oil than with coal. It seems to me that the combustion of pulverized coal, in suspension, will approximate oil burning conditions, and yet I understand that the nozzle can be increased in area very greatly. I should like to have this explained.

Following are some extracts from a letter from a correspondent in Chicago, the engine referred to being the Atlantic type on the Chicago & North Western, which Mr. Muhlfeld mentioned: "Some time ago you wrote me inquiring about the Chicago & North Western pulverized fuel locomotive. I had a ride on it the other day and was very much impressed with its performance. The fireman seemed to have as good control of the boiler pressure as the engineman had of the speed.

"The engine is of the Atlantic type and had 3-in. safety valves. During the trying-out period these were increased to 3½ in. and then to 4 in., as neither the 3½ nor the 3-in. valves could take care of the pressure. This engine is equipped with three burners, and on this run, which was a suburban run from Chicago to Waukegan, only two were used. The fireman controls the amount of fuel burned by means of a rheostat, which controls the speed of the screw conveyor that feeds the coal to the firebox. He would anticipate the engineer by 15 or 20 seconds in closing the throttle, reducing the fire to practically nothing, and by careful manipulation he did not permit the opening of the safety valves once during the trip. There was a layover of an hour and a half at Waukegan and the fire was put out entirely for about three-quarters of an hour. About a half-hour before leaving time the pressure had dropped to about 150 lb., and one burner was started, the fuel igniting from the heat of the arch and other brick work. The pressure was raised to 185 lb., the working point, in due season for starting. A very high temperature is obtained in the firebox which thoroughly consumes the coal while on the road. After the engine has stood awhile at the terminal a little smoke will be produced on starting, inasmuch as the temperature has not been raised sufficiently to insure immediate combustion, but the smoke is practically negligible and the practice may be considered smokeless.

"While it is desired to use the pulverized fuel with only two per cent moisture, I believe the engine that day was operating with coal having five or six per cent. That is another reason for producing a little smoke when the temperature of the firebox is not at the highest point. With the Illinois coal they find that a little honeycomb forms on the tube sheet and has to be removed at the end of each trip. This is done with a rod through a hole in the side of the firebox. With the Eastern coals I understand that this trouble is not experienced. On this trip the operation was entirely dustless in the cab, although I believe a little dust might be expected.



Arrangement of Pulverized Fuel Burning Equipment with Steam Turbine Drive

From an operating standpoint the scheme seems to be a great success."

In closing the discussion Mr. Muhlfeld said that the average cost for briquetting coal is from 75c. to $1 per ton and the average cost for pulverizing is 11c. per ton; the pulverized coal does not have the objectionable features as to combustion that briquettes do.

Considerable experimenting has been done to determine the best size of exhaust nozzle to use when burning pulverized fuel and while these experiments are not yet complete, it is probable that an increase in nozzle area of 25 per cent over that used in hand firing will prove to be the most advantageous.

The Delaware & Hudson engine, which is the one shown in the illustration, is to use pulverized fuel obtained from tailings which pass through a 3/32-in. mesh screen. They are easily dried and have a heat value of 12,000 B. t. u. per ton. It is not yet known what proportion of this quality of coal can be used. It is probable that there is no saving in total

weight in the Delaware & Hudson locomotive but some of the weight is transferred to the tender.

Replying to questions, Mr. Muhlfeld said that the collection of slag on the back tube sheet is due to incorrect combustion conditions and that adjustments can be made to eliminate this. Experiments are now being made to determine the best combination of conditions to avoid this accumulation. The pulverizing of the coal for locomotive use is best done at the coaling stations, as it is not practicable to haul pulverized coal in any large quantities in cars and store it for future use.

GRAPHITE IN LOCOMOTIVE VALVE CHAMBERS AND CYLINDERS

BY M. C. M. HATCH

Superintendent Fuel Service, Delaware, Lackawanna & Western, Scranton, Pa.

Two sources of power loss other than those of a strictly thermodynamic nature, occur within the cylinders and valve chambers of a steam locomotive. These are sliding friction between the packing rings of the piston and valve and the surfaces against which they work, and leaks or "blows" past the packing rings. The first of these, except under extraordinary conditions, is not of very great moment, probably approximating not more than 2 per cent of the indicated power of the engine. This, of course, assumes good lubrication; dry cylinders and valves will increase this amount very materially. It is safe to assume that no locomotive is entirely free from loss of the second class and this may be so large as seriously to affect the operation of the locomotive. Constant endeavor is required to keep them to a minimum.

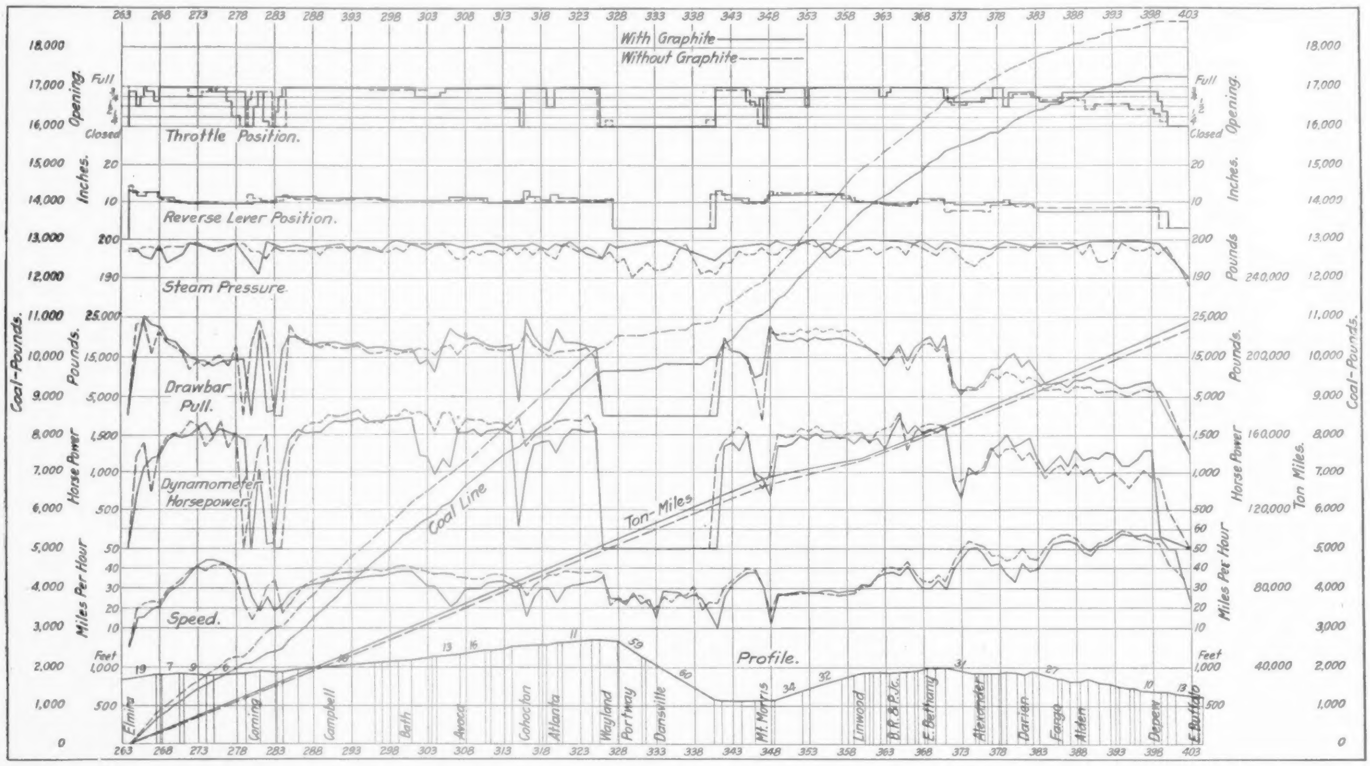
Lubrication is, primarily, an effort to reduce friction by interposing between the moving surfaces a film of oil, grease or other material of like character, which shall keep them from actual mechanical contact. The friction of lubricated surfaces between which this film is continuous, will follow approximately the laws of fluid friction, which is dependent to some extent upon the degree of roughness of the surfaces. In other words, the smoother the moving surfaces, all other conditions being kept constant, the less will be the friction loss between them. Any machined surface has more or less roughness and if some medium can be used which will smooth up this roughness to an appreciable degree, lubrication will be improved. Graphite properly applied will do this, giving the surfaces a glazed finish and affording the fluid lubricant fed to them a better opportunity to do its work effectively.

"Blows" are the result of scratches or scorings in cylinders, valve bushings or packing rings, which allow the leakage of steam from a zone of high pressure to that of lower pressure. Here again graphite tends to fill up these scores and, consequently, to reduce the leakage loss. This action always follows the use of graphite, no matter whether the blows are great enough to manifest themselves as a roar at the stack or are practically infinitesimal in magnitude. In the following table are shown the results of some valve leakage tests which were included in a report presented before the American Railway Master Mechanics' Association in 1904. These tests were made after the engines had been in service for varying periods, the worst performance recorded having been made after a service of 39,000 miles:

Type of valve and number tested	Leakage in pounds of water per hour		
	Least	Greatest	Average
Piston, 14 locomotives..........	268	2,880	1,208.99
Slide, 11 locomotives...........	384	2,610	1,224.54
Average, all valves tested......	...	.....	1,215.83

On the basis of these tests it was estimated that the average loss in coal for each engine, ten hours a day, evaporation being figured at seven pounds of water per pound of coal, was 1,736.9 lb. a day, 26.05 tons a month and 312.14 tons a year. An investigation made by the writer some time since on a slide-valve engine showed that the valve leakage was reduced 51 per cent by the use of graphite for a period of about 10 days.

Graphite in flake form has been administered to locomotive cylinders and valves for many years, as the besmeared ends of relief valves bear ample witness. The usual method, however, in which the material was introduced in a single large quantity, is not ideal as much of it will be lost out of the exhaust without ever reaching the wearing surfaces. Ob-



Comparison of Average Results of West-Bound Trips with and without Graphite Lubrication

viously the proper way is to feed very small quantities continuously just as oil is fed by the hydrostatic lubricator. About four years ago a lubricator for thus feeding graphite was developed and applied to a Lackawanna switching locomotive. This machine operates by means of an abrasive wheel oscillated by mechanical connection with some part of the valve motion of the locomotive, on which bears a stick composed of graphite in the flake form held together by a small amount of vegetable binder. The movement of this wheel grinds off small particles of the graphite stick which are carried directly into the steam chest and thence to the cylinder. The sticks are 1 in. in diameter and 1 in. long and it has been found that one stick per cylinder is an ample supply for a run of 100 miles; the magazine of the lubricator, however, holds four sticks which insures its not being necessary to put graphite in the lubricator on the road.

The general results obtained from the use of this lubricator were satisfactory and as it was recognized that it should have some advantageous effect on the general operation of the locomotive, it was determined to ascertain quantitatively just what this effect was. With this in view a series of road tests was conducted.

The locomotive was a Pacific type with 25-in. x 28-in. cylinders, in manifest freight service over a division 140 miles long, the profile of which is shown on the dynamometer chart. Tests were first made without the use of graphite; lubricators of the form briefly described above were then applied, and a duplicate series of tests run, all conditions with the exception of the use of graphite being kept as nearly constant as possible throughout both series. Westinghouse dynamometer car No. 2 was used to measure the work done at the drawbar and care was taken throughout to secure the highest degree of accuracy possible in a road test.

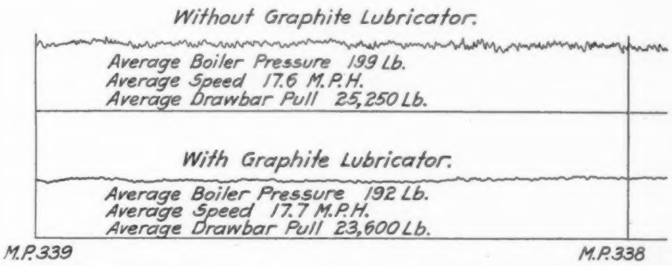
COMPARATIVE PERFORMANCE OF ENGINE 1165 WITH AND WITHOUT GRAPHITE CYLINDER LUBRICATION

Number of round trips	2	4
Distance run, miles	560	1,120
Total time	20 hr. 17 min.	39 hr. 38 min.
Running time	18 hr. 37 min.	35 hr. 43 min.
Duration of test (throttle open)	14 hr. 48 min.	28 hr. 4 min.
Number of stops	17	33
Temperatiure of air, total	66.9	70.2
Diameter of exhaust nozzle, in.	6 9/16	6 9/16
Speed, average m. p. h.	30.2	32.6
Boiler pressure, average, lb.	196.3	196.9
Coal, as fired, total, lb.	66,337.5	141,864.6
Coal, dry, total, lb.	64,526.7	137,900.5
Dry coal fired per hr., lb.	4,359.9	4,912.6
Dry coal per hr. per sq. ft. grate area	75.17	84.7
Water delivered to boiler, total, lb.	504,477.6	1,014,909.9
Water delivered to boiler per hr., lb.	34,086.3	36,151.1
Equivalent evaporation from and at 212 deg., lb. per hr.	42,340.1	44,858.8
Equivalent evaporation from and at 212 deg., lb. per hr. per sq. ft. heating surface	10.07	10.67
Equivalent evaporation from and at 212 deg., lb. per hr. per lb. dry fuel	9.70	9.13
Boiler hp.	1,227.3	1,300.2
Efficiency of boiler	67.8	63.9
Gross tons, total	6,339	12,478.5
Gross ton miles, total	887,460	1,746,990
Dry coal per 1,000 ton miles	72.71	78.94
Number of cars, total	219	420
Car miles, total	30,560	58,800
Dry coal per car mile	2.11	2.35
Drawbar pull, average, lb.	15,372	14,619.4
Drawbar hp., average	1,240.6	1,266.4
Million ft.-lb. work per hr.	2,460.8	2,511.4
Dry coal per drawbar-hp.-hr. lb.	3.53	3.89
Water per drawbar-hp.-hr., lb.	27.49	28.55

By referring to the summary of the test results it will be seen that the dry coal performance per 1000 ton-miles was 7.88 per cent less when graphite was used than without it. This checks very closely with the average of several other weighed fuel tests, in which a saving of from 7 per cent to 13 per cent has been made. On the drawbar-horsepower-hour basis 10.2 per cent less coal was burned when graphite was used, this latter unit being the most equitable for comparative use, where obtainable.

It will be noted that with graphite the average speed, on account of operating conditions, was somewhat lower than without but that the average drawbar pull was higher, the total work done being very nearly equal. The fuel rate with graphite was very considerably reduced, resulting in an increase in boiler efficiency and equivalent evaporation. This can be attributed to the more effective working of the locomotive, as will be noticed later. The water rate shows an improvement of 3.71 per cent. and this, combined with the more efficient boiler operation mentioned above will account for the over-all advantage attributed to the use of graphite.

The small diagram illustrates one of the most interesting points in the whole discussion. It represents the drawbar pull lines of the locomotive as registered by the dynamometer over the same length of track and under very nearly the same conditions except that graphite was used in one case and not used in the other. The reduced fluctuations show very clearly that the turning action of the wheel at the rail was considerably more uniform in one case than the other, and this can only be accounted for by the assumption that the jerky action of the valve was eliminated by the use of graphite, allowing the valve gear positively to control the workings of the valve and thus improving the steam distribution to the cylinders. The smooth and positive action of the valve gear with graphite has been apparent before this particular test was made, these results only confirming previous observations. It is believed that this is one of the reasons why an improvement was shown in fuel consumption, the engine developing the same power at a somewhat shorter cut-off on account of better steam distribution.



Typical Drawbar Pull Lines Taken on a 1.15 Per Cent Grade; Cutoff 14 in.

Like anything else, the application of graphite to the valve chambers and cylinders can be overdone, its introduction in too large amounts causing trouble from stuck rings and blocked ports. But if it is applied "homeopathically" instead of "allopathically," it results in a material improvement in the general performance of the locomotive. It is of special value with locomotives using highly superheated steam because of its refractory nature; it saves water and coal; it reduces packing ring, rod packing and bushing wear, and it makes the valve motion easier to handle.

INCANDESCENT HEADLIGHTS AND HEADLIGHT LAWS

There is little doubt in the minds of the majority of railroad officers that the incandescent electric headlight is far superior in every way to the arc headlight, but in many cases they are a little dubious about adopting the former type in the face of the chaotic condition of the various state headlight laws, which in most cases specify that a headlight shall be used with a light source having an intensity of not less than 1,500 candlepower, measured without the aid of a reflector. Under such conditions they feel that the only headlight which will meet these requirements is one having an electric arc for a light source. In this connection it is interesting to note that the master mechanics' test at Columbus brought out the fact that none of the arc lights which were tested showed an unaided candle power of over 1,000. The strongest arc gave about 894 candle power without a reflector. Taking a specific case, arc-lamp headlight number 19 with an apparent beam candle power of between 55,000 and 60,000 had a lamp which gave 941.88 candle power without the

aid of a reflector, whereas incandescent lamp headlight number 13½ required only a 90.2 candle power lamp to give 55,000 apparent beam candle power; it seems, therefore, that there is not one arc lamp used in headlight service today that will meet the 1,500 candle power requirement of several of the state laws. Another fact brought out in the report of this test, which shows that the arc headlight is unsuitable for railroad service, was that a headlight with a beam candle power of over 50,000 develops about 30 per cent phantom lights. That is, a red and green signal would show white, and in addition it was shown that with an opposing arc light about 39 per cent of the red flag signals ahead of the engine, on which the observers were located, were obliterated or missed.

Another serious inherent fault of the arc lamp, when used as a headlight, is that its light is extremely rich in blue rays and consequently this type of lamp produces a large amount of light which is of no value whatever in enabling the engineman to identify an object on the track. For this reason a tungsten filament incandescent lamp, which gives a white light, is from eight to ten times as efficient as an arc lamp of equal current consumption as regards the distance at which a certain object can be picked up on the track by the headlight.

If the motive behind the legislation in the different states affecting the headlights were to be analyzed it would be found without a doubt that the object was not so much to secure a headlight with a high candle power source as to secure a headlight which was better and more reliable and satisfactory than those which were in general use at that time. It was simply a case of using an unfortunate definition, not realizing that the candle power of the lamp used in a headlight plays very little part in the final results, the size and shape of the reflector and of the light source, the condition of the reflecting surface and the quality of the light being, in many cases, more important than the candle power of the lamp itself.

Considering the fact that the arc headlight not only does not meet the requirements of the 1,500 candle power laws, but in addition is objectionable and dangerous because of the blinding and phantom light effect of its high intensity, unsteady and concentrated beam and because of its high maintenance cost and its unreliability due to the complicated arc lamp mechanism, it seems that its continued use in locomotive headlights is unwarranted when a much more satisfactory substitute is at hand.

Incandescent headlights of various makes and voltages are on the market and both the 6-volt and 32-volt sizes have proved reliable and efficient from all viewpoints, including those of track illumination and energy consumption.—*Railway Electrical Engineer.*

Abuse of High-Speed Drills.—Nothing will crack a high-speed drill more quickly than to turn a stream of cold lubricant on it after it has become heated by drilling. It is equally bad to plunge it into cold water after the point has been heated by grinding. Either of these practices is certain to impair the strength of the drill by starting a number of small cracks.—*The Engineer.*

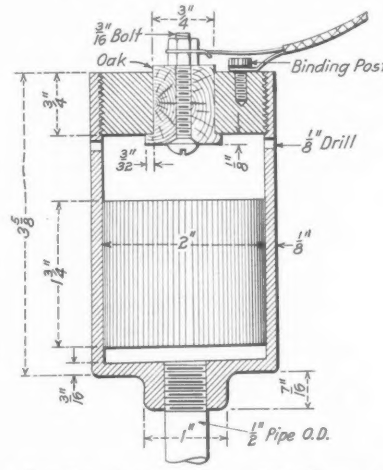
Pulverized Peat for Swedish Locomotives.—Experiments in the use of peat powder or pulverized peat on locomotives of the Swedish state railways have demonstrated that locomotives using this fuel can haul as heavy trains and make as good speed as locomotives using anthracite coal. The railway directors have decided to undertake the development of this kind of fuel. Two methods will be followed. Two experts have been requested to give complete estimates of the cost of preparing a certain bog and the running expenses with the respective methods. The bog selected is said to have an area of about 500 acres.

COAL COUNTER FOR USE IN LOCOMOTIVE TESTS

BY HUGH G. BOUTELL

On the drawing is shown a simple device which is designed to provide a ready means of automatically recording the number of scoops of coal fired on a locomotive equipped with an air-operated fire door. In making road tests, where the coal is not actually weighed it is the usual practice to place an observer in the cab to record on a tally sheet the number of shovelfuls of coal fired during the trip. Where a dynamometer car is used each shovelful may be recorded directly on a counter in the car by means of a push button and an electric circuit from the cab to the car. Neither of these methods is entirely satisfactory, however, because it requires an extra man in the cab. It is also quite likely that his attention may be diverted from time to time, when he will lose count of a few scoops of coal.

The simple device illustrated registers every time the fire door is opened and with a good fireman this is practically equivalent to registering the number of scoops of coal fired. The cylinder is turned out of brass and accurately finished to a diameter of 2 in. on the inside. In this cylinder is a simple brass piston 1¾ in. long, working easily in the cylinder



Electro-Pneumatic Counter for Use with Pneumatic Fire Doors

bore. The lower end of the cylinder is turned with a boss, into which is screwed an air pipe leading to the fire door cylinder. The upper end of the counter cylinder is threaded and into it is screwed a 2-in. plug about ¾ in. long. A ¼-in. hole is drilled out in the center of the plug, into which is driven a piece of oak, turned with a small shoulder on one end to keep it from working up in the plug. The oak piece is drilled for a 3/16-in. bolt, which passes up through the wood, the head projecting into the cylinder. This forms one terminal of an electric circuit and the other is formed by a small machine screw in the pipe plug. To these terminals are attached the wires connecting with the counter and battery in the dynamometer car. At the top of cylinder, just below the plug, are drilled four ⅛-in. holes to allow any air that may pass the piston to escape.

When air is admitted to the fire door cylinder it also fills the small counter cylinder, thus causing the piston to rise, completing the circuit and registering on the counter. When the air is discharged the piston will fall of its own weight.

The piston may be oiled occasionally, but too much oil should not be used.

Moment of Friction.—Frictional resistance of a bearing is the resisting torque, or so-called moment of friction, or it may be defined as the quotient of the resisting torque by the mean radius of the journal.—*Power.*

NORFOLK & WESTERN ELECTRIFICATION

Some of the Results with Single-Phase Equipment; Locomotive Inspection and Repair Facilities

The electrified section of the Norfolk & Western is located in the southern part of West Virginia in the Pocahontas coal district and extends from Bluefield to East Vivian, a distance of about 30 miles. There is a total of about 100 miles of single track in the electrified zone, including the double track main line and the numerous side spurs.

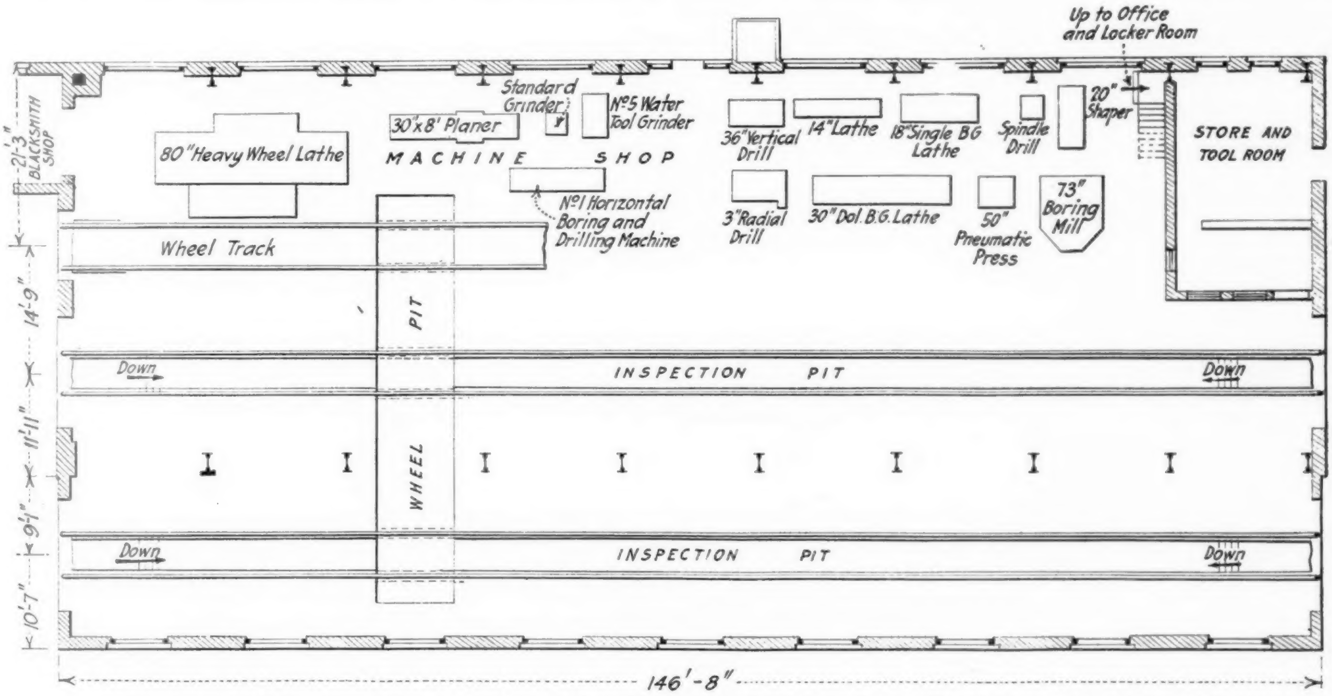
The 3,100-ft. Elkhorn tunnel is the only part of the electrified section not double tracked. The line between Bluefield and East Vivian, which winds around a narrow steep-sided valley, is very crooked, about 60 per cent of the entire division being curved, with a maximum curve on the main line of 12 deg. The grades are also numerous and heavy, the four-mile approach to the Elkhorn tunnel from the west being 2 per cent and the one-mile approach from the east being 2.36 per cent.

The main traffic, which consists of loaded coal cars, is eastbound. The westbound traffic is for the most part, empties which are distributed to the various mines on the west slope. Considering the roadbed conditions outlined above, together with the fact that the average eastbound traffic, at the present time, is about 35,000 tons per day, with 3,250 tons per train, it is easy to understand why the high voltage overhead trolley system was chosen. The system finally installed is known as the single-phase, 11,000-volt trolley system, which consists of an 11,000-volt catenary-suspended trolley, from which current is collected by a bow pantagraph on the locomotive. A transformer carried in the locomotive cab transforms the voltage from 11,000 to 750 and a phase converter, operating at the latter voltage, furnishes three-phase current to the wound-rotor induction motors, of which there are eight on each locomotive. The system operates at 25 cycles. The motors are wound for two synchronous speeds, 14 and 28 miles per hour, and are started by inserting water rheostats in series with the rotor windings.

The 12 locomotives, which are now in service, have developed a much higher drawbar pull than was guaranteed by the builders. They consist of two units, each of the 2-4-4-2 type and weighing 135 tons, the total weight being 270 tons. The tables show their principal dimensions and performances.

Length overall	105 ft.	8 in.
Driving wheel base, total	83 ft.	10 in.
Rigid wheel base	11 ft.	0 in.
Truck wheel base	16 ft.	6 in.
Height, rail to pantagraph (locked)	16 ft.	0 in.
Height, rail to top of cab (maximum)	14 ft.	9 in.
Width overall (maximum)	11 ft.	6¼ in.
Width over cab body	10 ft.	3 in.
Diameter of driving wheels		62 in.
Diameter of truck wheels		30 in.
Weight on drivers	220 tons	
Total weight of locomotive	270 tons	

	Train on 1.5 and 2 per cent grade	Train on 1 per cent grade	Train on 0.4 per cent grade
Weight of trains, tons	3,250	3,250	3,250
Locomotives per train	2	1	1
Approximate speed, miles per hour	14	14	28
Drawbar pull per locomotive, pounds:			
Uniform acceleration	91,800	114,000	79,400
At speed on 2 per cent grade	75,400	....	....
At speed on 1 per cent grade	....	85,800	....
At speed on 4 per cent grade	....	....	4,600
Maximum guaranteed accelerating tractive effort per locomotive	133,000	133,000	90,000
Approximate maximum guaranteed hp. developed by motors	5,000	5,000	6,700



Plan of Locomotive Inspection Building at Bluestone, Showing Location of Inspection Pits and Machine Tools

The traction powerhouse is located in Bluestone, about 14 miles west of Bluefield. Single-phase power is obtained from three-phase turbo-generators, which have a single-phase rating of 10,000 kw. at 80 per cent power factor. The current, after being stepped up to 44,000 volts, is transmitted to the various substations, where it is again stepped down to the trolley pressure of 11,000 volts.

OPERATION

Early in 1914 the average number of trains hauled by steam engines in both directions over the section under consideration was nine, each train weighing about 2,900 tons. This is equivalent to 26,100 tons per 24-hour day. Each

train was hauled by from two to three Mallet compound locomotives, depending on the grade, and a total of 20 such engines were required for this service.

The use of electric locomotives has had a marked effect on the operation of trains through the Elkhorn tunnel. The despatcher will now allow a full tonnage train to leave Eckman Yards, eastbound, ten minutes before a local passenger train is due, and will allow the same train to enter the tunnel four or five minutes ahead of a passenger train, as he is perfectly sure that it will come through without delay. Formerly, 20 minutes was the time figured on for a train with three Mallet engines through the tunnel, not only because its speed was less, but also because of frequent stalling. Two electric locomotives consistently pull 3,250-ton trains through the tunnel in about three minutes.

It will be of interest to follow an electric locomotive on one of its regular round trips over the line from Bluefield to East Vivian or Eckman and back. (The main yards at the west end of the line are at Eckman.) Leaving Bluefield inspection track, the locomotive goes to the West Bluefield Yards, picks up a train of from 85 to 95 empties, and proceeding westward, sets them off at the various mines in the coal field west of the tunnel. Proceeding to Eckman, the locomotive, without turning, picks up what is known as a tonnage train of 3,250 tons, consisting of from 28 to 45

N. & W. ELECT'N.
NOS. OF CABS—ELEC. LOCOS.
.m. — 191 .

LOCO. NO.	EAST CAB.	WEST CAB.
2500	E—...........	E—...........
2501	E—...........	E—...........
2502	E—...........	E—...........
2503	E—...........	E—...........
2504	E—...........	E—...........
2505	E—...........	E—...........
2506	E—...........	E—...........
2507	E—...........	E—...........
2508	E—...........	E—...........
2509	E—...........	E—...........
2510	E—...........	E—...........
2511	E—...........	E—...........

Gen'l Foreman Elect'n.

Form Used to Keep Record of Cab Numbers

cars, depending on their capacity, and starts east. A pusher is used from Eckman to Ruth (at the eastern portal of the Elkhorn tunnel and at the summit of the two per cent grade). The single locomotive then takes the train to Flat Top Yards, where additional tonnage up to 4,750 is accepted. The run from Flat Top to Bluefield is made with the help of a pusher, on the three-mile, 1¼ per cent grade at the end of the division, between Graham and Bluefield.

The round trip from Bluefield to Eckman and back is made in the average time of seven hours, and two such trips constitute an average day's work for one train crew. Formerly, with steam operation, a day's work for one train crew consisted of a single round trip between Bluefield and the coal field, which usually took 12 hours. There are usually 9 of the 12 electric locomotives actually on the road, with one at Bluestone undergoing general repairs, one idle at Bluestone for relay and one over the inspection pit at Bluefield.

Some ammeter readings taken on one of these trips may be of interest. These readings were taken from the four ammeters in the cab, each meter registering the current taken by each of the four trucks. Normally the current taken by the different trucks is equal; therefore, the total current taken by the locomotive is four times the reading of one ammeter.

The train (westbound) consisted of one electric locomotive with a trailing load of 92 empties. When going up a 1.4 per cent grade west of Bluestone at 14 m. p. h. the ammeter showed 500 amperes, and when coasting down the two per cent grade through and west of the Elkhorn tunnel an average regenerative current of 300 amperes was registered. Later, when coming east with 23 75-ton cars (over half a normal tonnage train) with one locomotive, the ammeter showed 550 amperes on the two per cent up grade and a regenerative current of 400 amperes on the 2.36 per cent down grade. One locomotive will take a full tonnage train of 3,250 tons down the 2.36 per cent grade at about 15 m. p. h. without air brakes. Under such conditions, which are normal, the regenerative current per truck is about 550 amperes. The regenerative ability of the three-phase motor

Form M. P. 392-E.

Norfolk & Western Railway Company

INSPECTION CARD

ELECTRIC LOCOMOTIVES.

LOCOMOTIVE No.............. CAB No..............

ITEM		NAME
1	PANTAGRAPHS & GROUND SWITCHES	
2	BELL & CORD	
3	HEADLIGHTS	
4	ROOF WIRING.	
5	OIL CIRCUIT BREAKER.	
6	MAIN TRANSFORMER.	
7	PHASE CONVERTER.	
8	PHASE CONVERTER AIR GAP, BOTTOM.	
9	STARTING MOTOR.	
10	COMPRESSOR.	
11	FAN.	
12	MAIN KNIFE SWITCH.	
13	SWITCH GROUPS.	
14	REVERSERS.	
15	POLE CHANGEOVER SWITCHES.	
16	CONTROL CHANGEOVER SWITCHES.	
17	RHEOSTATS.	
18	MAIN MOTORS.	
19	MAIN MOTOR AIR GAP, BOTT. 1 2 3 4	
20	MAIN MOTOR AIR GAP, SIDES. 1 2 3 4	
21	MAIN MOTORS BLOWN OUT.	
22	GEARS & PINIONS.	
23	MOTOR-GENERATOR.	
24	RELAYS.	
25	METERS.	
26	COMPENSATORS.	
27	CONTROL & LIGHTING TRANSFORMER.	
28	LIGHTING CIRCUITS.	
29	REACTANCE COIL.	
30	WIRING.	
31	MASTER CONTROLLER.	
32	AUXILIARY CONTROLLER.	
33	BATTERIES.	
34	HEATERS.	
35	FLANGE OILER.	
36	HAND PUMPS.	
37	WATER PUMPS.	
38	SANDERS.	
39	AIR BRAKES.	
40	CONTROL AIR SYSTEM.	
41	CAB.	
42	CAB BLOWN OUT.	
43	TRUCKS.	
44	DRAFT GEAR.	
45	JACK SHAFTS.	
46	JACK SHAFT OIL CUPS.	
47	T. L. JUMPER.	
48	OIL & GREASE.	
49	TOOLS & EQUIPMENT.	
50		
51		

______________ ______________191___

Inspection Card Used in Connection with the General Inspection of Electric Locomotives at Bluestone

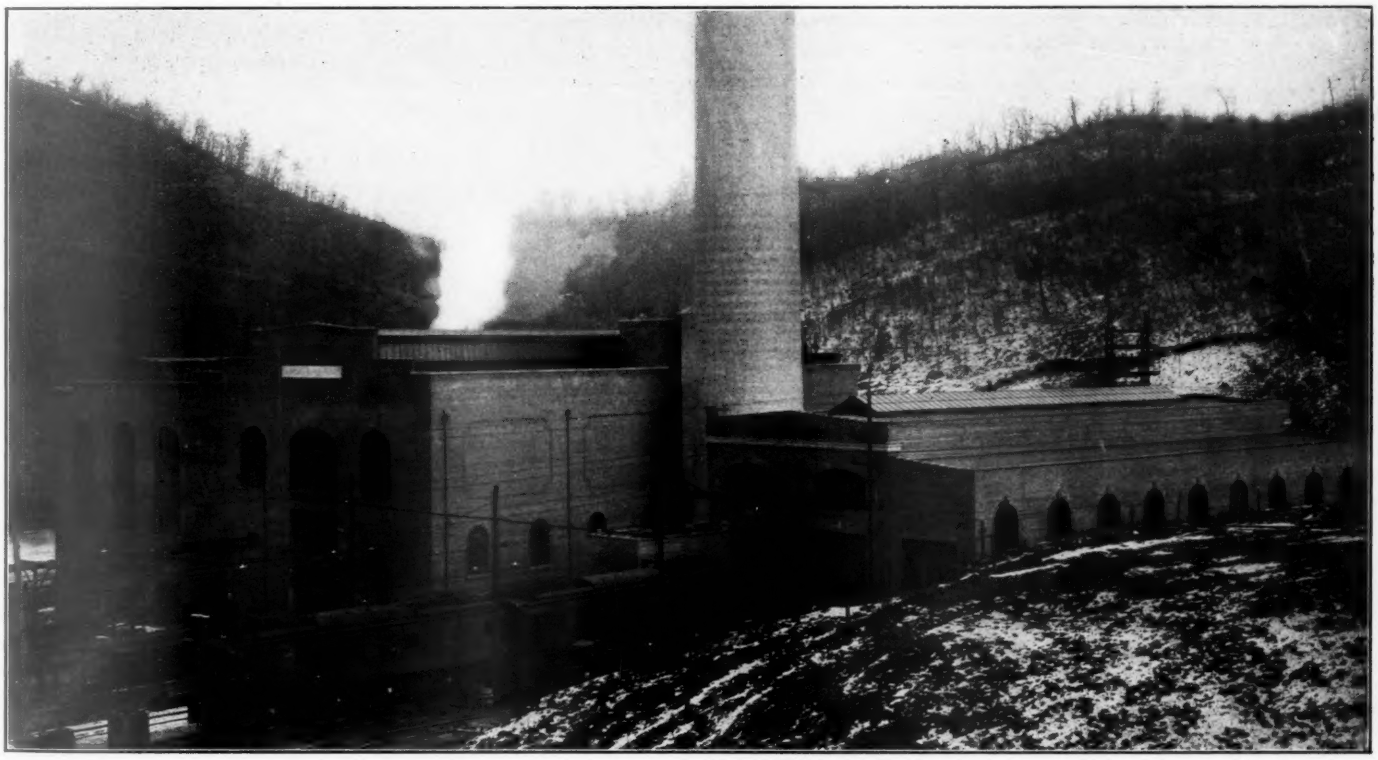
is one of the main factors which makes their use for this severe service particularly successful. Another characteristic of the three-phase motor which has proved most valuable is its inherent ruggedness, due to the absence of a commutator.

When starting a heavy train on a grade with a steam locomotive the pusher does not shut off steam when the head engine stops the train with the air brakes. It simply holds against the train with open throttle and in so doing permits the head engine to release the air and pick up its share of the slack when ready to start. When the front half of the train is under way the pusher will start its half and the entire train will move with a minimum of jarring and bumping. Of course, poor track and weather conditions may complicate matters to such an extent that perhaps three or four minutes might be required to start.

The three-phase motors on the electric locomotives are peculiarly adapted to stand up under the severe conditions above mentioned when starting a heavy train. In fact, their ability to stand still under full load for a maximum of five minutes, while holding a train about to be started on a heavy grade, contributes in a large measure to their success in this installation.

LOCOMOTIVE MAINTENANCE

The facilities provided for the inspection and maintenance of the electric locomotives appear small when compared with the extensive and elaborate facilities required for the proper maintenance of an equal power in steam locomotives. One rather small machine and inspection shop at Bluestone and one small frame office and store building, an open air inspection pit and six sand boxes, at Bluefield, are all the electric locomotive facilities provided. The absence of roundhouses, coal docks, cinder pits and water tanks is particularly noticeable. The general inspections and heavier repairs are made in Bluestone, a point about 11.5 miles west of Bluefield, while the terminal inspections and light running repairs are made at Bluefield, the eastern terminus of the electric zone.



Power House and Locomotive Inspection Building at Bluestone

When considering the question of providing proper maintenance facilities for the entire installation, it was decided that Bluestone was the logical site for the main locomotive inspection and maintenance building, because of its central location as regards the electric zone, and because the power plant was to be located there, near the only available water supply.

The locomotive inspection building at Bluestone is a substantial brick and steel structure 148 ft. by 68 ft., similar in style to the power plant. This building is shown on the right of the power house in one of the illustrations. By referring to the floor plan it will be noted there are two inspection pits running the full length of the building, with a wheel pit connecting them with the wheel track in the machine tool bay. The inspection pits are of concrete, are well drained and are provided with numerous lighting, power and compressed air outlets. The wheel pit is equipped with a narrow gage track for the transfer of wheels between the locomotives and the wheel track, as they rest on a wheeled pneumatic jack.

The pit furthest from the machine bay is used almost exclusively for inspection purposes, and to facilitate this inspection a platform, 112 ft. long, and located 12 ft. 8 in. above the rails, has been erected near it.

All erection and repair work is done over the other inspection pit and in the machine bay. This part of the shop is served by a 30-ton Whiting crane equipped with a 30-ton main hoist and a 5-ton auxiliary hoist.

Some of the machine tools installed in the machine shop are individually motor-driven and part are arranged for group drive from one motor-driven line shaft. All motors are 220-volt, direct current. The machine tools installed are:

MOTOR DRIVEN

Description of tool.	Hp.	Motor R.P.M.
80-in. driving wheel lathe	50	500-1,000
73-in. boring and turning mill	2	1,200
	12	375-1,500
30-in. x 30-in. x 8-ft. planer	5	1,100
36-in. x 15-ft. engine lathe	12.5	400-1,600
60-in. x 6-ft. boring and drilling machine (hor.)	4	500-750-1,500
20-in. crank shaper	4	500-750-1,500
3-ft. radial drill	3	1,000

BELT DRIVEN GROUP

18-in. x 10-ft. engine lathe		
36-in. vertical drill		
14-in., 2 spindle, sensitive drill	15	825
36-in. x 4-in. wet tool emery wheel		
Size c, Diamond double emery grinder		

LARGE PNEUMATIC TOOLS

600-lb. single frame hammer
45-ton rod bushing press
Wheel jack

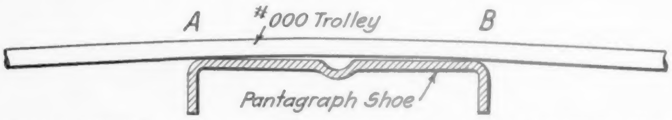
In addition to the above a winch driven by a 15-hp., 1,650-r. p. m. motor is located just outside of the western end of the shop for moving the locomotives which are being inspected or repaired.

The overhead system of electric lighting is employed, with large tungsten lamps in enamelled metal reflectors located on the steel roof trusses. A special feature of the lighting system is the use of 100 and 60-watt lamps in angle reflectors, which are mounted on the side walls, about 10 ft. from

the floor. Extension cord receptacles are provided where necessary.

LOCOMOTIVE INSPECTION

The general inspection routine requires under normal conditions that one locomotive be sent to the shop each day. Rotating the 12 locomotives in this way insures that each one receives a general inspection every 12 days. Of course, extra heavy repairs upset this plan, but as a general thing it is closely followed. Immediately after a locomotive arrives in the shop it is given an inspection card, as illustrated. As will be noted, this card gives a complete list of the locomotive parts to be inspected. Each man in the inspection force is permanently assigned to cover a certain number of these items, the total being divided between seven wiremen, one airbrake man, one machinist and one pipefitter. In this



Sketch Showing How the Upward Thrust of the Pantagraph Shoe Curves the Trolley Wire So That It Makes Contact with the Shoe at Points A and B Only, Thus Causing Greatest Wear at Those Points

way the work for each man is automatically outlined in advance and no time is wasted giving routine instructions. When the card is hung on the locomotive the force of inspectors start to work and as the inspection of each item is completed the man responsible marks his initials after it in the column headed "Name." Any fault found is immediately reported to the foreman inspector, who takes steps to have it corrected.

As each electric locomotive is made up of two distinct units or halves, it is possible to take one-half of one locomotive and attach it to a half of another locomotive. In other words, these units or halves are interchangeable. This arrangement has proved most convenient, because it often happens that two locomotives require repairs to only one of these units at the same time. By the simple expedient of coupling the two good halves together, one good locomotive is made from two which would otherwise be unfit for serv-

Locomotive Inspection Facilities at Bluefield; a Pit, Which Cannot be Seen is Located in the Second Track in Front of the Frame Building

ice. Such a practice necessarily requires some special system for keeping the locomotive numbers straight. The system used is to give permanent distinctive numbers to the cabs (as the units are called) and temporary numbers to the entire locomotive of two cabs. The cab numbers are on a brass plate riveted to each end of the cab on the inside and consist of the letter E and a number. The locomotive numbers are on removable plates hung on the outside of each cab. A record showing the cab numbers assigned to each locomotive number is kept and each time a change is made copies of the corrected list are sent to the officers interested.

The maintenance facilities at Bluefield, where terminal inspections and light running repairs only are made, consist of a small frame building containing an office, an oil room, a locker and wash room and a store room. An open air inspection pit and six elevated sand boxes are also provided. The day inspection and maintenance force at Bluefield consists of an inspector, a clerk, a wireman, a machinist, a pipefitter, an oiler and three laborers. The night force consists of a machinist, a pipefitter, and oiler and two laborers. Except for the electric light wiring, no inspection is made of the electric apparatus at night. The locomotives are expected to be ready for service after a layover of 40 minutes at Bluefield, except in cases requiring extraordinary repairs. This means that a locomotive is idle for inspection only about two hours out of every 24, or about 8 per cent of the time.

LOCOMOTIVE PERFORMANCE

In general, it can be said that the locomotives have more than come up to expectations in their ability to stand up under the most severe traction conditions in the world, and considering the racking service and the fact that these are the first locomotives built to haul such enormous trains over heavy grades, their performance has been remarkable. No tires have been replaced since electric operation was inaugurated in May, 1915. Any flat spots that have appeared have been filled up by electric welding and then ground off to the proper contour.

The solution in the water rheostats (water and soda ash) is renewed about once a week. The renewable steel pantagraph shoes have a serviceable life of from two to three months, the greatest wear taking place along the edges of the shoe. This is evidently because its contact surface is flat, whereas the trolley wire, at the point of contact, takes the form of a long radius arc due to the upward thrust of the pantagraph. This condition is of course exaggerated in the sketch. It is usually found that while the shoe wears through along the edge, the metal near the center is hardly touched.

SPONTANEOUS COMBUSTION OF COAL

BY J. F. SPRINGER

The Canadian Pacific maintains at Montreal a coal pile whose maximum capacity amounts to about 250,000 tons. This coal is a good quality of bituminous from the Sydney coal field on Cape Breton Island, Nova Scotia and is brought to Montreal by boat during the warm season. During the winter when river navigation is closed, the coal is mined and stored in piles at the mines. These piles give practically no trouble from spontaneous combustion, although the piles are quite deep. At Montreal, on the contrary, much trouble has been experienced from this source and yet the depth of storage is only about half that at the mines. The New York Edison Company maintains a big bituminous storage yard where the coal is piled up to heights of about 35 ft. Spontaneous combustion gives trouble here also. Indeed the subjct is one of importance to all consumers who maintain bituminous piles from 20 to 40 ft. in depth.

As is generally known, spontaneous combustion is the ignition and burning of coal without the assistance of an outside source of high temperature either at the beginning or during the progress of the fire. The coal in the hold of a vessel will at times take fire and burn for days or weeks, not only without assistance but despite efforts to put out the fire. The fire will originate in the depths of the pile and spread from that point. The causes and prevention of spontaneous combustion are subjects which have engaged serious attention for a number of years and considerable information of value is now available. Spontaneous combustion, like ordinary combustion, requires two things: a temperature high enough to cause ignition and a supply of oxygen. But it should be noted that it is only necessary that a small part of the pile

be at the temperature of combustion to start the fire. Once it is started, of course, the high temperature spreads.

Various suggestions have been made as to air movements through a coal pile. A report of two or three somewhat casual inspections of a large pile ventilated with a number of vertical holes passing from top to bottom states that they failed to indicate a down draught; warm air appeared to rise from all the holes, and in winter when the pile was covered with snow, melted passages through to the surface. Coal stored on wet, impervious soil is more apt to suffer from spontaneous combustion than coal stored on dry sand or on a thick bed of cinders. It is not clear, however, that this must be explained on the basis of the want of circulation in the one case and its existence in the other.

The oxygen to support the combustion, however, does not appear to come directly from the air above and around the coal pile. The action which takes place will be understood from the following considerations. It is estimated that of the 42 or 43 cu. ft. occupied by one ton of steam coal 12 cu. ft. are filled with air. This is too small a quantity by itself to effect more than an insignificant amount of combustion. But steam coal is said to be capable of absorbing double its own volume of oxygen in the space of 10 days. Using this as a basis, one investigator calculates that the 30 cu. ft. of actual coal in a ton absorbs 60 cu. ft. of oxygen in 10 days. This is the amount of oxygen in 300 cu. ft. of fill air. Consequently, to secure this amount of oxygen necessitates 25 changes of air in 10 days. This indicates a slow circulation, a complete change of air taking place in about 9 1-2 hours. This estimate cannot be applied to all coals or all conditions of the same coal, but it seems probable that a circulation of air really takes place, and that this circulation is a fundamental factor to be considered in dealing with spontaneous combustion.

Another important fact is that the temperature of the coal rises continuously as the absorption of oxygen goes on. The results of an investigation made at a British colliery clearly indicate the truth of this statement. At the shaft bottom the temperature of the air of the intake airway was 60 deg. F.; at the return airway, it was 17 deg. higher. Some of this rise was doubtless due to the higher temperature of the strata passed over by the air in its course through the mine. But as the temperature of the strata at the bottom of the pit was only 68 deg., there remains a considerable rise unaccounted for by the mere depth below the surface. A certain amount of heat was supplied by living bodies, candles, settling of strata overhead and friction. But these were estimated to total no more than 20 per cent of the observed increase. It would seem then that we have here a case of heat being supplied by the oxidation of exposed coal in the mine passages. In fact, the body of coal behind the exposed surfaces was itself being heated. In the course of about four years the coal 10 ft. back gained from 17 to 24 deg. in temperature.

That oxygen was being lost from the air was indicated by analyses of air taken at various points in its passage through the mine. The average loss of oxygen was found to be something over three times the gain of carbon dioxide, an excessive ratio. Further, some of this coal in a powdered condition was put into a flask which was then sealed. A gage was arranged to determine the pressure of the air in the flask. At once, the tension began to diminish. It continued to diminish for nine days, when it became practically stationary. After six months an analysis of the air within the flask showed that the oxygen had disappeared; nitrogen forming about 98 per cent of the remaining gas. No doubt, this coal is somewhat exceptional so far as the amount and rate of absorption are concerned, but the fact that bituminous coal absorbs oxygen and that this absorption is accompanied by the evolution of heat, is of general application.

Another fact which seems well founded is that the rate of absorption of oxygen increases with the rise in temperature. Thus in the case of the British coal already mentioned it was determined that the rate was just about doubled for every rise of 30 deg. F. in temperature. As absorption of oxygen becomes more rapid, the evolution of heat must take place with greater rapidity and we have the conditions for a constant acceleration of the increase in temperature. A coal pile is a poor conductor of heat. Whatever heat it loses is carried off by the air circulation, which, as has been pointed out, is comparatively slow. In view of these facts it is not difficult to conceive of a temperature being reached in the heart of a large, deep pile, high enough to cause ignition. There being oxygen at hand, the requirements for combustion are met and a fire starts.

A French investigator some years ago constructed a pile of slack coal 130 ft. long and varying in height from zero to about 20 ft. At the top, the pile was about 3 ft. wide. Daily temperature readings were taken at several points along the pile, all of which were near the bottom, but the distance from the bottom increasing with the depth of the pile. The test covered a period of about three months. Except for the points near the low end of the pile, the temperature rose steadily, reaching a maximum at the end of the test. Through that part of the pile where the depth was about 13 ft. or less, the temperature never rose higher than about 160 deg. F. Beyond this height, the temperature continued to rise until the pile caught fire. Such atmospheric conditions as the temperature and dry or wet weather had no appreciable influence on the temperatures within the pile, except at the extreme low end.

From a general review of this subject certain American investigators have found nine factors which are generally considered of especial importance in their relation to spontaneous combustion. These are: The proportion of volatile matter; the purity; the presence or absence of sulphur compounds such as pyrites; the temperature of the coal; its size; the presence of occluded gases; the presence of moisture; the accessibility of oxygen; and the pressure on the coal.

Anthracite coals with their low volatile content are practically exempt from spontaneous combustion, while pure bituminous coals seem to be more subject to it than others of less purity. Opinions differ with respect to the part played by pyrites. It is well established that pyritic coals are liable to an increase of temperature due to oxidation of the pyrites. Coals containing little or no pyrites, however, ignite spontaneously.

From the preceding brief description of the process which results in the final ignition of coal in large piles it may be expected that the initial temperature of the coal will have a marked influence on the trouble experienced from this source. If the temperature is high when the coal is stored not only is the interval up to the ignition point reduced, but the initial activity of the oxidation process is increased. We may have in this a partial explanation of why Cape Breton coal stored at Montreal in warm weather gives trouble while the same coal stored at the mines in cold weather gives no trouble. That the liability to spontaneous ignition is much increased either by a high initial temperature or by a rise in temperature due to the proximity of steam pipes and flues or even from the heat of the sun, is generally accepted. The danger point beyond which the liability is decidedly increased is usually placed at about 150 deg. F. An external source of moderate temperature may facilitate spontaneous combustion by causing the release of inflammable gases which are occluded in the coal.

That heated coal is dangerous coal, even though the temperature be well below the ignition point is brought out clearly by the following experiment tried in an investigation of spontaneous combustion. A pile of coal containing about two tons was arranged in the form of a cone. A ditch around the base, filled with water, provided a seal for a cover which completely

enveloped the pile. The coal was heated to a temperature of about 212 deg., F. A number of holes in the cover were left open and in the course of two days the pile set itself on fire. The spontaneous combustion thus produced was stopped by simply closing the holes. By this means the temperature was reduced to 140 deg. In fact, the temperature could be made to rise or fall simply by opening or closing the holes in the cover.

Oxidation of hydrogen and carbon at rather low temperature (from 250 deg., F. up) is dangerous largely because of the amount of heat liberated. This leads to the next step, the autogenous oxidation of the coal which is independent of external heat for its maintenance. The temperatures of this stage range from about 390 deg. F. to over 500 deg., and it leads to ultimate ignition. The ignition temperature varies for different coals, usually falling somewhere between 700 and 900 deg. F.

There is a general agreement that the finer the coal the more rapid the oxidation, which in effect means the greater the liability of spontaneous combustion. The reason is probably to be found in the greater total surface presented to the action of the oxygen in fine coal as compared with lump. Even the fine coal resulting from handling may be productive of danger since it accumulates near the bottom of the pile, a situation favorable to the accummulation of heat. Friable coals appear to be especially subject to spontaneous combustion.

The danger from occluded gases seems to be due to their release and oxidation, the heat thereby liberated raising the temperature and promoting conditions favorable to self-firing.

As to the part played by the presence of moisture there is a great difference of opinion. One authority claims that weather conditions have but little to do with spontaneous combustion. Another claims that spontaneous firing arises from the action of ozone formed "by the action of the sun on warm, sunny days following a rain, when the surface evaporation is especially great." The following statement is made as the result of an investigation of Illinois coal. "Any coal with conditions favorable to oxidation will be facilitated in that action by moisture. It is to be noted in this connection that the normal water content or vein moisture of coals in this region (Illinois) is rarely below 10 per cent and ranges usually from 12 per cent to 15 per cent. The presence of such water must be borne in mind in considering the likelihood of chemical activity on the part of the pyrites present. Without exception, in all the series of tests, the wetting of the coal increased the activity as shown by the ultimate temperature."

The accessibility of oxygen is undoubtedly a large and important factor in causing ultimate ignition. Precisely what the reaction of the oxygen is does not seem as yet to have been clearly established. One conception considers the oxygen as uniting directly with the hydrogen and the carbon in the coal; another considers that it combines with unsaturated humus bodies. What is clear, however, is the fact that the oxygen is absorbed and heat liberated.

Pressure as a contributory cause of spontaneous combustion seems to be favored by some investigators. In fact, it is generally conceded that deep piles are dangerous piles. Two storage plants were maintained by an Australian gas company, the depth of the pile in one being about 14 ft., while in the other it was 20 ft. No case of spontaneous combustion is reported in connection with the shallower pile. On the other hand, a great deal of care was required to prevent spontaneous combustion in the deeper pile, all other conditions except depth of pile being the same at both piles. The experience of the Chicago & Alton some years ago with three different piles of run-of-mine Springfield coal, point to the same conclusion. Two of the piles were each 6 ft. high, while the third was 10 ft. high. All three contained a very considerable percentage of slack. The first two piles escaped firing, but the last caught in several places. Attention has also been directed to the fact that the third pile was a broad one, while the others were comparatively narrow. It is doubtful, however, whether the width had any influence in effecting the spontaneous combustion.

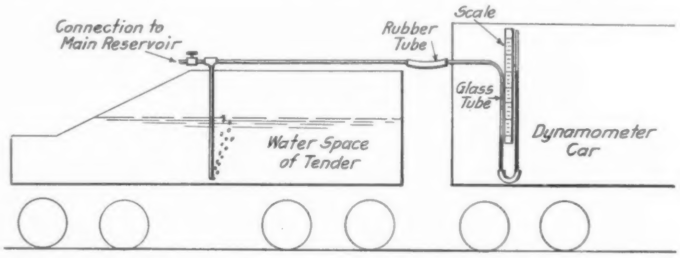
WATER READINGS IN LOCOMOTIVE TESTS

BY TOWSON PRICE

In making locomotive tests in which the coal and water are measured, it is desirable to take frequent readings of the depth of water in the tank. This is usually done by having two small valves with nipples tapped into the tank at opposite corners to which glass tubes are connected by means of rubber tubing. The glass tubes are applied along scales attached to the sides of the tank and the readings taken from them are then averaged.

There are two disadvantages to this method. The readings to be accurate have to be taken when the engine is stopped and on nearly level track and in cold weather the water in the valve or tube is liable to freeze. The following method of determining the height of the water in the tank eliminates these disadvantages and has been used with success.

Instead of measuring the height of water in the tender directly, the equivalent of the water pressure on the bottom of the tender is transmitted to the dynamometer car by means of a flexible tube and the height of the water there shown by means of a glass U-tube and movable scale. The point at which the pressure is determined should be directly below the center of gravity of the average amount of water carried in the tank.



Method of Taking Tenders Water Level Readings in Dynamometer Car

The arrangement of the air pipe and the U-tube connections are shown in the illustration. The valve connected to the air line is left open slightly so that the air will just bubble out of the bottom of the vertical pipe through the water in the tender. This creates a pressure in the horizontal pipe which is connected by a rubber tube to the glass U-tube in the dynamometer car. With the air just bubbling slowly into the water, the pressure in the U-tube, which is balanced by the column of water as shown, should be exactly equivalent to the water height in the tender if the vertical tube extends very close to the bottom of the tank. For the greatest accuracy the water in the U-tube should be at the same temperature as the water in the tender, but a slight variation in temperature makes very little difference in the accuracy.

INCREASING VALVE TRAVEL.—In engines having the valve moved by a rocker-arm that receives motion from the eccentric rod, the valve travel can be increased by reducing the radius of the eccentric rod rocker-arm or increasing the radius of the valve-rod rocker-arm.—*Power.*

SIZE OF RETURN-TUBULAR BOILERS.—The nominal horse-power size of horizontal return-tubular boilers of ordinary proportions, as commonly rated, can be roughly estimated by multiplying the square of the diameter in feet by the length in feet and dividing the product by five.—*Power.*

CAR DEPARTMENT

RATIO OF STRESS TO END LOAD FOR FREIGHT CAR CENTER SILLS

BY C. M. FARIS

The writer finds so many mistakes made by draftsmen in using the M. C. B. formula for finding the ratio of stress to end load, and misconceptions regarding the meaning and value of the term so common, that he believes a simple explanation of the principles of mechanics upon which the formula is based may prove of value to many of those who are called upon to apply it to problems of car design.

The expression, "the ratio of stress to end load," and the formula for its definition, $\frac{1}{A} + \frac{X}{SM}$ (where A is the area in sq. in. of the cross section of the center sill, X the distance in in. from the neutral axis of the section to the center line of the resultant of the end load, and SM is the modulus of the section) were recommended by the committee on car construction of the Master Car Builders' Association in 1913, as a means of clearly defining the strength requirements of steel

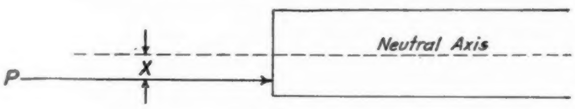


Fig. 1

center sills. The necessity of establishing a standard of minimum strength for steel center sills became evident in connection with the settlement for damages in interchange service soon after the introduction of steel underframes in car construction. Some designs of steel center sills were strong enough and no damage need be expected to occur to them in fair usage. The handling company, therefore, could justly be held responsible for any damages that might occur. On the other hand, some steel center sills were so faulty in design and so weak that it would be unjust to charge the handling company with their maintenance. This condition led to the recommendations of the committee, above referred to.

The principle involved in the action of buffing forces on center sills when considered as static loads applied at their ends, is essentially that of the column. With the load applied, not on the center line or neutral axis of the column, but to one side, as is usual with draft attachments to the center sills, we have the conditions of a column with an eccentric load. The committee provided for simple strut or column action by requiring that the members subject to end load be "anchored at intervals not exceeding 20*d*," where *d* is the depth of the member in inches measured in the direction in which buckling might take place. With the recommendation that the ratio of stress to end load should not exceed 0.06 for new cars, a standard of minimum strength of center sills to resist buffing loads has been established.

In considering the principles of mechanics involved, it should be noted that the conditions to be dealt with are those of a short column with an eccentric load, because the sills or members are required to be securely anchored at such regular intervals as will provide against the effects of long column action. In the expression, "ratio of stress to end load," the maximum allowable stress in pounds per square inch produced in the sill by the end load or buffing force, is referred to, and the term, end load, refers to the buffing force in pounds, considered as a static load. If P is the end load and S is the stress, then the ratio of stress to end load is $\frac{S}{P} = \frac{1}{A} + \frac{X}{SM}$, from which $S = \frac{P}{A} + \frac{PX}{SM}$, which is the ordinary formula from mechanics for finding the stress produced in a short column by an eccentric load.

The stresses in a column under eccentric load may be considered as made up of two parts; one is the direct stress and is given by $\frac{P}{A}$, the other is the eccentric stress and is given by $\frac{PX}{SM}$. The direct stress is compression uniformly distributed over the area of the cross section, while the eccentric, or bending stress, is a tension on one side and a compression on the other. The resulting combined stress then is the sum of the direct and the eccentric stresses on the compression side of the column and the difference between these stresses on the tension side.

For sills that have a symmetrical section, a mistake can hardly be made in using the formula. But for sills with an unsymmetrical section, which is a common condition for freight car center sills, there will be two sections moduli and mistakes are commonly and frequently made in using the wrong one. Let Fig. 1 represent an unsymmetrical center sill with the center line of the end load P applied at a distance X, below the line of the neutral axis. Let SM_t be the section modulus of the sill for the top of the section and SM_b the section modulus for the bottom. For this condition the formula for the stresses in the top of the sill is $S = \frac{P}{A} - \frac{PX}{SM_t}$ and, for the stress in the bottom of the sill, $S = \frac{P}{A} + \frac{PX}{SM_b}$. To find the ratio of stress to end load for this condition that

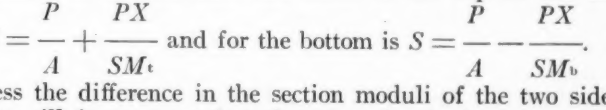


Fig. 2

value of S should be used which is a maximum. This is ordinarily at the bottom, and is $\frac{S}{P} = \frac{1}{A} + \frac{X}{SM_b}$.

In Fig. 2, the end load is shown applied above the neutral axis, and in this case the stress in the top of the sill is $S = \frac{P}{A} + \frac{PX}{SM_t}$ and for the bottom is $S = \frac{P}{A} - \frac{PX}{SM_b}$. Unless the difference in the section moduli of the two sides of the sill is so great that the stress in the bottom is greater than the stress in the top, the ratio of stress to end load is $\frac{S}{P} = \frac{1}{A} + \frac{X}{SM_t}$. If the center line of the buffing load coincides with the neutral axis of the sill the eccentricity X is zero and $\frac{S}{P} = \frac{1}{A}$.

It is evident that the specification, requiring a ratio of stress to end load not to exceed .06, fixes the minimum

strength of the sills. If we assume that $S = 21{,}000$ lb. per sq. in. as a safe unit stress for the material, then the safe buffing capacity of the sills will be $\frac{21{,}000}{.06} = 350{,}000$ lb. Assuming, as recommended by the committee, that the sill stresses due to loading may be neglected, then the simple fixing of this constant for steel sills definitely fixes the requirements for buffing strength without reference to the eccentricity of the application of end load, or other conditions of the details of design.

TANK CAR SPECIFICATIONS MODIFIED

The Master Car Builders' Association has issued Circular No. 17 modifying the standard specifications for tank cars to conform to the recent ruling of the Interstate Commerce Commission. The circular is as follows:

The Interstate Commerce Commission upon the recommendation of Colonel Dunn, chief inspector, Bureau of Explosives, following the explosion and fire at Ardmore, Oklahoma, September 27, 1915, in connection with tank car loaded with casinghead gasoline, issued an order January 20, 1916, modifying its Regulations, paragraph 1824 (k), governing the transportation of liquefied petroleum gas (casinghead gasoline).

The requirements of the order, including 25-lb. setting for safety valves and the automatic venting of pressure, become effective March 15, 1916, as to tank cars for casinghead gasoline shipments; and on January 1, 1917, these two requirements become effective as to all tank cars for shipment of inflammable liquids with flash point lower than 20 deg. F. The requirement that tank cars for the transportation of the products described in the order shall have their safety valves set to open at a pressure of 25 lb. per sq. in. by the dates fixed, makes necessary in the case of such cars a modification of the M. C. B. standard specifications for tank cars, now requiring 12-lb. setting for safety valves for ordinary tank cars.

To set the safety valves to open at a pressure of 25 lb. per sq. in. requires the removal of the present spring for 12-lb. setting and the substitution for it of a new spring meeting the following specifications:

Diameter of bar	9/16 in.
Outside diameter of coil	6⅛ in.
Length of bar	86⅜ in.
Tapered length of bar	95 in.
Height, solid	2¾ in.
Load, solid	1,005 lb.
Minimum height with load of 500 lb.	5½ in.
Maximum free height	8¼ in.
Normal weight	6 lb. 1 oz.
Minimum weight	5 lb. 10 oz.
Coiling	Right or left hand
Ends ground.	

This spring can be inserted in the spring case of the present standard 5-in. safety valves in place of the 12-lb. spring now used. The present spring for 12-lb. setting must not be used for 25-lb. setting, as any attempt to set the valve for the increased pressure by screwing up on the 12-lb. spring will cause the spring to go solid, and the valve will no longer be a safety valve.

In stenciling the test record on the tank after testing at the 25-lb. pressure, the words "with 25-lb. spring" must be added to the stenciling now required by the specifications, thus:

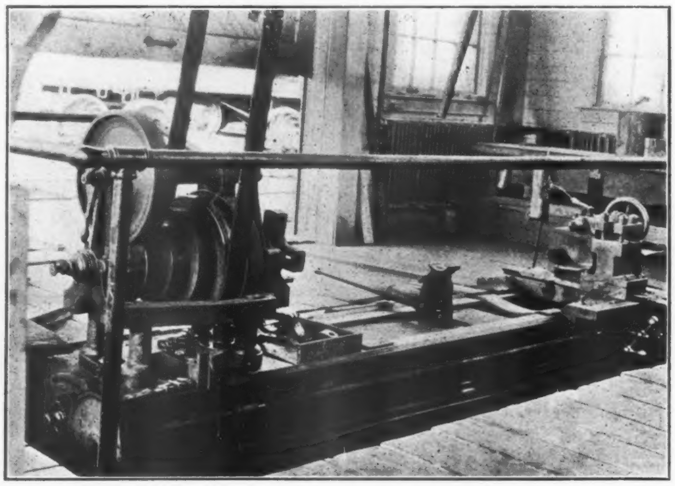
SAFETY VALVES WITH 25-LB. SPRING
Tested (date) ....
Pressure (lb. per sq. in.) ....
At (place) ....
By (name of firm) ....
(No change in the requirement as to stamping date of test and pounds pressure to which valve was tested on body of valve.)

To comply with the order as to automatically venting the pressure in the tank before the dome cover is removed, an approved method for the modification of existing dome covers consists in drilling horizontally through the bottom flange six ½-in. holes, at root of the screwed portion, as close as possible under the top flange. Where the length of the screwed portion is not over 1¼ in., it is recommended that not less than nine 5/16-in. holes be drilled, instead of the six ½-in.

Any other arrangement which will insure the relief of internal pressure before the removal of the dome cover will be acceptable if first submitted to and approved by the Master Car Builders' Association.

TURNING CAR JOURNALS

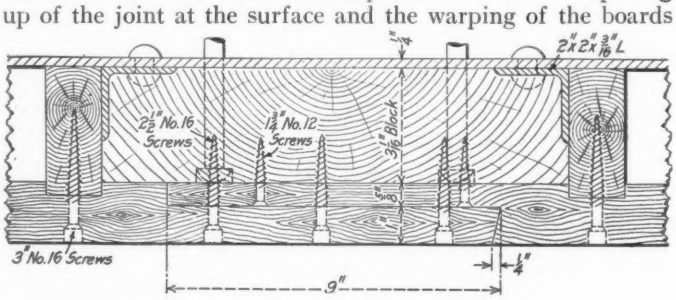
An interesting arrangement of a lathe for turning car journals in use at the Clinton shops of the Chicago & North Western, is shown in the accompanying illustration. The lathe is located in a pit sufficiently deep to bring the ways at the approximate level of the floor. The car wheels are rolled in through the door shown in the background, and onto the lathe over iron bars extending between the ways and the floor. The wheels are raised to the proper position for the centers by the hand-jack located between the ways. By this method it is an easy matter for one man to handle the entire work, as the machine may be loaded with but very little effort.



Arrangement of a Lathe for Turning Car Journals

LETTER BOARD SPLICE

The illustration shows a horizontal section through a coach letter-board splice which is in use on the Canadian Northern. With other types of joints and splices which have been tried considerable trouble has been experienced from the opening up of the joint at the surface and the warping of the boards near the ends. The new splice was developed to overcome these difficulties.



Canadian Northern Letter Board Splice

The construction of the splice is clearly shown in the drawing. As will be seen the surface portion of the joint is beveled so that the warping of the overlapping tongue is prevented. The splice is shown as applied to the road's recently built composite steel and wood passenger equipment.

LIFE AND MAINTENANCE OF STEEL CARS

A Discussion of the Life, Depreciation Rates, Deterioration, Rebuilding and Painting of Steel Cars

BY M. K. BARNUM
Superintendent of Motive Power, Baltimore & Ohio

When the first steel cars were built, the advocates of this form of construction claimed that these cars would be practically indestructible, and their life so much greater than that of wooden cars that it was very difficult to estimate it. A few years later, when steel cars came into general use on the larger railroads, the estimates of their life were placed at from 25 to 35 years, and in calculating the rate of depreciation, many roads adopted three per cent per year, whereas for wooden cars, it had for a long time been calculated at six per cent. It is now nearly 30 years since the first steel cars were built, and there has been a considerable difference in their durability. This has been found to vary according to the manner in which they have been maintained, the part of the country in which they have been mostly used, and somewhat with the character of the lading. However, the life of steel freight cars is much less than was expected.

So far as the writer has been able to learn, the oldest steel freight car now in service belongs to the Bessemer & Lake Erie. It was built in 1896, twenty years ago. The frame of this car was made of structural steel shapes, and it weighed nearly 42,000 lb., about 4,000 or 5,000 lb. more than many cars of the same capacity which were built later. Fig. 1, from a photograph taken in 1915, shows that the design of this car compares very favorably with the latest methods of construction, and also indicates that it has been very well maintained. The record of repairs shows that it has been kept well painted, this being the usual practice of the Bessemer & Lake Erie. Some of the doors and hoppers required new sheets after about nine years and at 14 or 15 years of age the floor sheets required extensive renewals and the side sheets and stakes had some repairs. At 18 years it received a new floor, two new corner side sheets, eight new hopper sheets and other repairs, and its appearance indicates that it may be good for at least 10 years more.

This car is apparently an exceptional case, for we find many thousands of steel gondola and hopper cars only 14 and 16 years old which have the sheets and underframes so weakened by corrosion and service that they do not justify the application of new material for general repairs, and many of these cars are now being destroyed on account of the bodies having reached their limit of life. This is about one-half the life which was originally expected from steel cars, and it is disappointing. It naturally follows that those roads which have calculated the depreciation of steel freight cars at three per cent, and now find many of them worn out at the age of 14 to 16 years, must charge quite a large amount to operating expenses when they have to be scrapped. If we assume the average life of a steel gondola car which cost $1,000, as 16 years, and the scrap value of the car to be $200, five per cent per year would be about the proper depreciation rate.

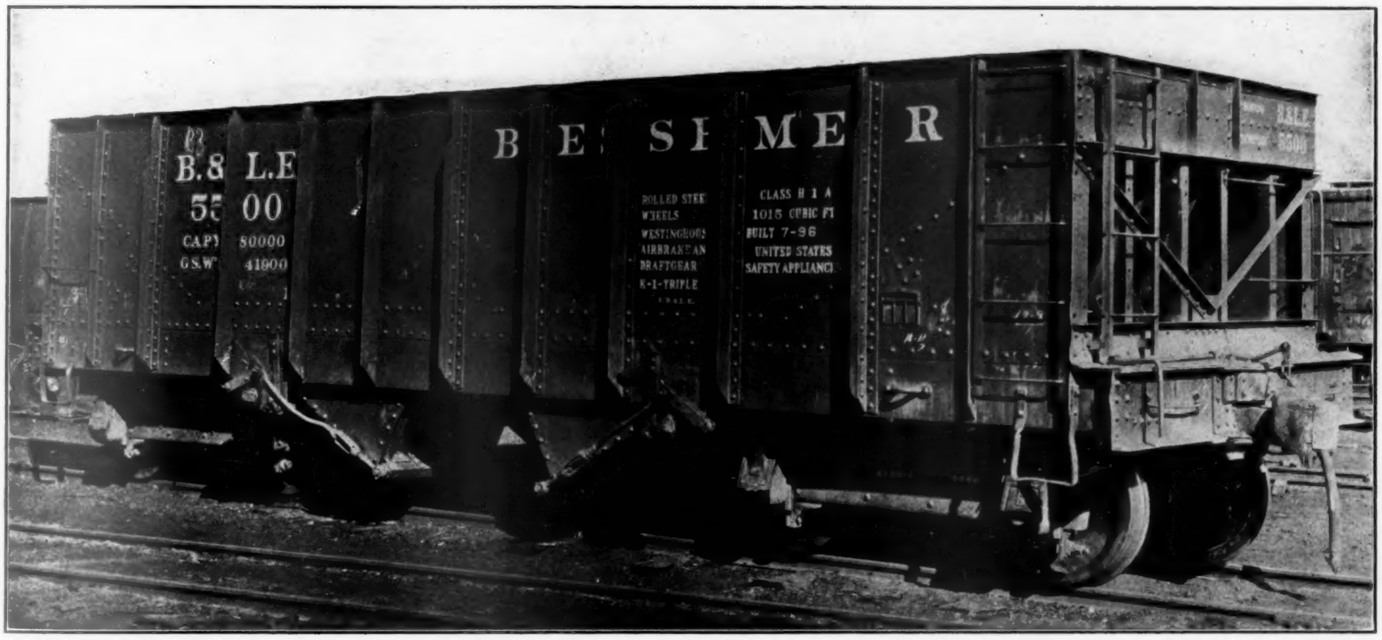


Fig. 1—Steel Hopper Car 20 Years Old; 80,000 lb. Capacity; Light Weight, 41,900 lb.

LIFE OF WOODEN COAL CARS

The records of a number of roads owning large numbers of wooden coal cars show that their life has varied between 16 and 20 years, and the average life has been about 17 years. This class of equipment has usually been condemned and dismantled on account of the underframes and draft attachments becoming worn out and too weak for the heavy modern trains of coal cars. But for this reason, the life of these cars undoubtedly would have been about 20 years, which is the average life of a box car. However, in comparing the life of wooden coal cars with that of steel, we should bear in mind the fact that most of the wooden cars are of 20 and 30 tons capacity and few, if any, are over 40 tons, whereas few steel coal cars have been built of less than 40 tons capacity and the majority of them carry 50 tons, while some are now being built to carry 75 and 90 tons.

LIFE OF IRON AND STEEL BRIDGES

The writer has obtained the views of a number of bridge engineers and engineers of maintenance of way, and most of

them say that the life of iron and steel bridges varies indefinitely, so far as actual durability is concerned, provided they are kept well painted, as they usually are, and the ordinary repairs are maintained. In some cases iron bridges 30 and 40 years old have been perfectly good so far as deterioration is concerned and have only been removed on account of the locomotives and cars becoming too heavy for their construction. Bridges which are exposed to salt air and water corrode rapidly and their life is comparatively short, and salt water drippings from refrigerator cars used for shipping fresh meat tend to corrode the girders quite rapidly where the amount of this class of business is large. In comparing the life of iron and steel bridges with that of steel freight

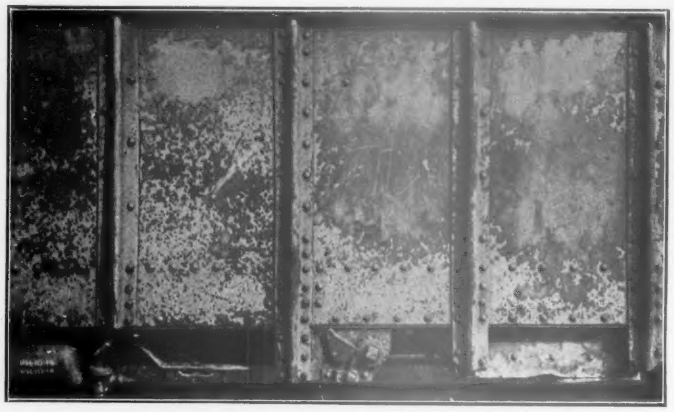


Fig. 2—A Car Four Years Old Badly Rusted on Account of Not Being Repainted at the Proper Time

cars, we find the principal differences to be that the bridges are kept well painted and their life is not shortened as much by corrosion as is that of freight cars which are not kept painted on the inside. Many cars are not kept painted on the outside, and they are subject to more severe and frequent shocks in service.

LIFE OF LOCOMOTIVE TENDERS

The locomotive tender more closely approaches the steel coal car in the service to which it is subjected and will afford a fairer comparison on this account. Locomotive tenders are usually kept well painted on the outside, and whenever the locomotive receives general repairs, ordinarily once in about two years, it is thoroughly cleaned and painted outside, and often a coat of paint is applied to the coal space and to the top

Fig. 3—A Steel Car Five Years Old in Which the Hopper Sheets Required Renewal on Account of Corrosion; Note the Rusted Condition of the End, Stiffening Rib and Buffer Plate

and bottom sheets. Many locomotives, thirty or more years old, still have the original tender in fairly good condition. The inside sheets have sometimes been renewed, but the original outside sheets often are in a fair state of preservation.

PRINCIPAL CAUSES OF SHORT LIFE OF STEEL CARS

There are many causes which tend to shorten the life of steel cars and the most active of these is corrosion. New steel cars are painted inside and out, but very few, if any, railroads attempt to keep the inside painted after the cars

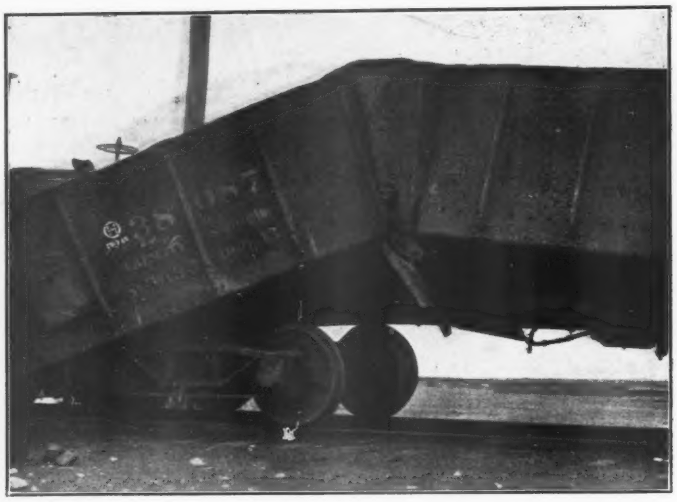


Fig. 4—A Steel Gondola Car Weakened by Corrosion and Buckled by Service Shocks

have gone into service, as it is thought that the effect of loading and unloading coal, ore, etc., is to wear the paint off so quickly that it would not last long enough to pay for the cost of the application. Therefore, the corrosion of the inside of such cars generally starts within a few months after they go into service. The paint on the outside varies in durability according to quality, the number of coats applied, and the manner of application, but it is nothing unusual to see cars only two or three years old the sides of which have begun to rust quite badly and Figs. 2 and 3 show cars only five

Fig. 5—A Steel Gondola Car Weakened by Corrosion to Such an Extent That It Finally Failed Under an Ordinary Load

years old which had but little paint left on them. It is pretty certain that if these cars had been repainted when two or three years old, before the rust had become so general, the corrosion on the outside would have been stopped and the life of the side sheets prolonged.

Some of the earlier steel cars were built so light, that they have become weakened by corrosion sooner than those of heavier construction, and such cars occasionally buckle up in trains as shown in Figs. 4 and 5. In designing steel cars, it has been a nice problem to determine just how far to go in putting in metal to increase the strength, and at the same time to cut out metal where it is not essential so as to keep the

dead weight down to a minimum consistent with good service. In this respect, the practice of different roads varies so that we still see steel gondola cars of 100,000 lb. capacity weighing only about 38,000 lb., while others of the same capacity weigh 7,000 or 8,000 lb. more. This matter of keeping down the dead weight has always been a hobby of such prominent railroad builders as E. H. Harriman and J. J. Hill, and little argument is needed to prove the desirability of keeping the

Fig. 6—A Steel Gondola Damaged Beyond Repair; the Two Ends Were Doubled Together in an Accident About as Shown in the Photograph and It Was Cut Apart to Facilitate Loading

dead weight as low as may be consistent with satisfactory service. The tendency during the past four or five years has been to increase, somewhat, the weight of cars, but this has generally been done, not by using thicker sheets for the sides and bottoms, but by strengthening the sills and reinforcing the top edges of the sides and ends, and also by adding more substantial draft gear. These improvements should increase somewhat the life of these cars over those of earlier design,

Fig. 7—A Drop Bottom Gondola with Floor and Sides Rusted so That no Sheets Were Fit for the Application of New Material

but in view of the heavier trains in which they are used it remains to be seen how far this will prove true. These problems of keeping down the dead weight of cars and eliminating those of weak design are not new, for in the proceedings of one of the earliest meetings of the Master Car Builders' Association, held nearly 40 years ago, we find a lengthy discussion about these same questions and at that time it was the consensus of opinion that in the 15-ton car the maximum capacity had finally been reached.

Other causes of the short life of steel cars are the strains to which they are subjected in unloading machines and also the use of sledges and bars in pounding the sides and hoppers when the coal freezes or clogs and requires loosening. Some of the later designs of cars are provided with holes framed into the sides and hoppers, through which bars can be introduced to loosen the coal when it lodges. Another cause of shortening their life is the heavier trains in which they are used, resulting in greater shocks than those for which they were originally designed. The effect of climate has quite an important bearing on the life of steel cars as there is a noticeable difference in the rapidity of corrosion of cars used mostly in proximity to salt water and to rivers where fogs are prevalent, and those which are kept principally in service in the dry climate west of the Missouri river. The writer's observations lead him to believe that corrosion is probably 25 per cent more rapid in the vicinity of the salt water than in the drier climate of the interior. The nature of the loading also affects the deterioration. One road which uses steel hopper cars almost entirely in iron ore service reports that, "as yet none of them show any effects of deterioration due to rust," although they are about 16 years

Fig. 8—Rusted Floor Sheet Cut from a Hopper Coal Car with a Broad Axe as Shown in Fig. 9

old. Coal having much sulphur and other impurities is more injurious to steel sheets than the better grades of coal, and wet ashes from cinder pits are especially active in hastening corrosion.

DIFFICULT PROBLEMS

For the first five or six years of the life of a steel car the repairs are light and it is easy to decide just what work should be done, but after eight or ten years the floor and hopper sheets of many cars have become so corroded that they must be renewed, and in some cases the sides also rust through at the ends and bottom while the rest of the sheets are worth preserving. After a few years more many cars become so generally corroded that it is doubtful whether the side sheets are strong enough to make it advisable to rivet new bottom and hoppers to them. Then the problem is whether to apply new side sheets, if the car has already had a new bottom and hoppers; or, in cases where these have again become weakened, to give the car general repairs using such of the original parts as may yet be serviceable; or to build an entire new body using the same trucks; or to dismantle the car entirely and eliminate it from the equipment list. Under these conditions the program will be more or less affected by the capacity of the car and the desirability of improvements in the design and the operating mechanism.

When steel cars become damaged in wrecks, the question of repairs is quite a different one from that of repairing wooden

cars, as in the latter case the damaged parts are removed and replaced with new sills, siding, flooring, etc., at a considerable expense for material. On the other hand, unless a steel car is damaged almost beyond recognition, the various parts can generally be straightened out and replaced on the car, if they were previously in good condition. One road, owning over 100,000 steel coal cars, has lost only about 20 of them on account of being damaged beyond repair, but if these had been wooden cars, probably many hundreds of them would have been destroyed within the same period.

On another road which has over 50,000 hopper and gondola cars, only about two per cent of the all-steel cars were damaged beyond repair during the first 12 or 13 years of their life, but of the composite cars having steel frames and wood

Fig. 9—Broad Axe Made by Drawing Out One End of a Sledge, and the Manner of Using It to Cut Rusted Steel Sheets

sides and bottoms, about 11 per cent were destroyed. This large difference was probably affected to some extent by the fact that the composite cars were not originally as well designed as the steel cars, but after making due allowance for this, the all-steel cars seem to have the advantage over the composite cars in the matter of durability.

REBUILDING STEEL CARS

On a road which owns a large number of steel gondola and hopper cars, the latter have been found to reach the limit of the profitable life of the body in about 13 or 14 years. When the cars were from eight to ten years old, it became necessary to renew the floor and hoppers, and in about four or five years more, the sides and other parts had become practically worn out, so that it was very doubtful whether the bodies were worth the application of more new material for repairs. A study of the subject indicated that an entire new body would cost only about $25 more than general repairs to the old body, retaining such parts as might be fit for further service. The trucks were in good general condition so that with the renewal of some worn parts, they could be made practically equal to new. The body after receiving general repairs was estimated as worth only about 65 per cent of the value, new, of a gondola and 75 per cent of a new hopper car, whereas the general repairs would probably not extend the life of the car more than six or eight years. The repaired car, if destroyed on a foreign line, would have its depreciation calculated from the date of its original construction, whereas the new body would have its depreciation calculated from the time when the body was built, which made a good argument in favor of a new body.

Other points in favor of the new body were that with the experience obtained from the maintenance of the old bodies, some improvements in the design were possible which would make the new body more satisfactory in service and better able to withstand the effects of heavy trains, dumping machines, etc. It would also have the further advantage of not being on the repair tracks as often as the repaired car. It was, therefore, decided to buy new bodies to replace the old hopper bodies of 100,000 lb. capacity and use the air brakes, couplers, draft gear and trucks of the old cars under the new bodies. In the case of the 80,000 lb. gondolas it was not

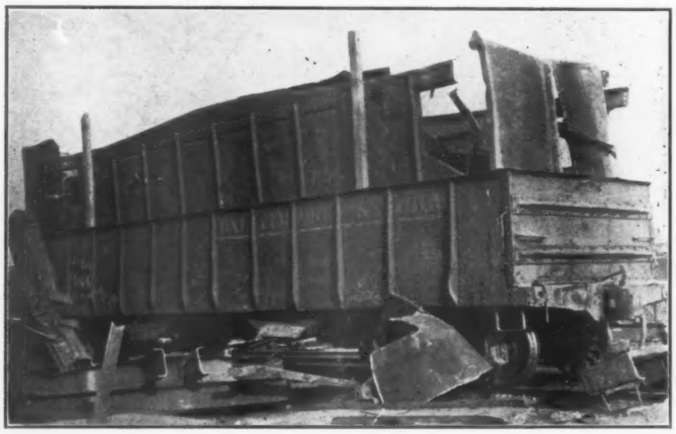


Fig. 10—Car Partly Loaded with Scrap Sheets from Hopper Coal Cars Showing the Extent to Which It Is Necessary to Cut Cars Down to Prepare Them for Sale and Shipment

thought profitable to perpetuate a steel car of this capacity, and therefore it was decided to use the trucks and other serviceable parts under new box and stock car bodies of 80,000 lb capacity. Figs. 4, 5, 7 and 8 illustrate some of the conditions found in the cars which had reached the limit of their life on account of the sheets being so generally weakened by corrosion that there was not enough good material left in the bodies to justify general repairs. Fig. 9 shows the method of cutting down the bodies of these old steel cars by using a heavy broad-axe to cut the thinner sheets. The oxy-acetylene blow-pipe process is used to cut the angles, sills and heavier sheets. By these methods, the total cost of cutting down a condemned steel hopper car body to sizes suitable for sale, was less than $6, including both labor and oxy-acetylene gas. Figs. 8 and 10 show the extent to which the old cars are cut up so as to be acceptable to the purchasers of scrap. Some of the end sills, gussets, side stakes and other parts of the condemned cars were considered worth saving for repairs to other cars which are to be maintained for a time and Fig. 11 shows a car load of this serviceable second hand material.

PAINTING STEEL FREIGHT CARS

There has been a good deal of discussion as to whether or not it pays to keep steel coal and ore cars well painted and the majority of superintendents of motive power believe that it would pay to do so, but many of the higher officers who are responsible for the entire cost of operation seem to have con-

cluded that it does not pay to paint them except when they receive new sheets or the letters and numbers need to be brightened up so that their ownership and identity can be distinguished. A committee of the Master Car Builders' Association investigated this subject several years ago and their conclusions as presented at the 1908 convention were as follows:

"We cannot be too emphatic as to the necessity of taking the proper care of the exterior, and regret that we are not able to give the interior the same care.

"The painting of the inside of steel cars has been thought by some to be beneficial, but your committee can see no lasting results in this, and do not recommend it, but is of the opinion that coating the interior of the cars about once every six months with black oil would act as a preservative."

During the following year a number of cars were painted with different mixtures for test purposes and special attention was given to painting the insides of the cars. At the 1909 convention the committee reported upon the painting of the inside of cars as follows:

"One car bearing mixture No. 4 was examined after being in service 4 months and 17 days and shows the inside well preserved, but considerable of the paint gone from the bottom, yet there seemed to be retardation of the rusting and no accumulation of scale. This mixture shows better results than mixtures Nos. 1, 2 and 3." (Mixture No. 4 consisted of 30 lb. of tar, 40 lb. of aniline oil and 170 lb. of corn oil.)

However, the committee's conclusions were, "It will be a very hard matter to find a preservative that will take care of the interior. The best preservative is to keep the cars in active service. Some steel cars that have been in active service for 10 years have the plates in excellent condition and from appearances, they are good for 10 years more. It is a pretty well known fact that where cars stand idle for a couple of months, the deterioration of plates on the inside is equal to two or three years' service."

Similar opinions were expressed by several of the members of the Association who took part in the discussion. So far as the exterior of the car was concerned, practically all those discussing the report gave it as their opinion that they should be kept well painted. Nevertheless, this practice has not been generally followed.

As to the frequency with which steel cars should be painted, there is quite a difference in opinion. Some roads paint them once in every three years, others once in four or five years and

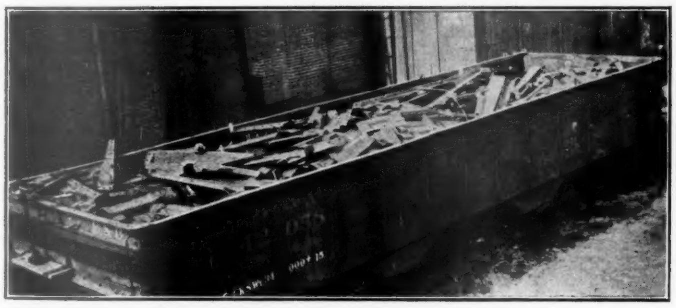


Fig. 11—Car Load of Serviceable Pressed Steel Shapes Saved from Dismantled Hopper Coal Cars for Repairs to Other Cars of the Same Class

others only when they receive new sheets in the course of repairs. Estimates of the cost of painting also vary widely, and as might be expected, those roads which paint their cars most infrequently are the ones on which the cost of painting is high, varying from $5 to $10 for each painting, while those roads which keep their cars well painted report the cost as varying from $6 to $1 for each painting. There would naturally be a considerable variation in the cost per painting according to the kind of material, the class of labor used and the condition of the car when painted, but a comparison of the figures indicates that it costs but little more during the life of the car to keep it well painted than it does to paint it only when the car becomes badly corroded and requires more thorough treatment.

The difference in the average age and condition of such cars as have been kept well painted and those which have not been so well maintained, makes it seem fair to conclude that thorough painting will probably prolong the life of steel freight cars between 25 and 50 per cent. Assuming that the average life of a car is 16 years, and that the cost per painting would be $5, it seems very probable that an expenditure of $25 or $30 additional for painting would prolong its life one third, or about five years. This is a conservative estimate and it would certainly be a good investment when applied to cars costing $1,000 apiece. Some other arguments in favor of keeping steel cars well painted are, that it will help to prevent their becoming weakened by corrosion so that they are liable to buckle up in heavy trains, also that the appearance of cars will be much better and although this may have no commercial value, yet it tends to create a favorable impression

Fig. 12—Side Sill of a Steel Car Seven Years Old, Showing Corrosion Due to Lack of Paint

about the owning road. The arguments which are often advanced against keeping steel coal and coke cars thoroughly painted, seem frequently to be applied to steel underframes and other parts of cars which do not come in contact with the lading, and these are often found to be so corroded that their life is much shortened. (See Fig. 12.)

STEEL PASSENGER CARS

The estimated life of steel passenger cars has been placed by various authorities at from 30 to 50 years, but as none of them are yet half that age there is no data at hand on which to base any definite conclusions. The elements affecting the deterioration of steel passenger cars are different from those which apply to freight cars but several years' experience with such cars show conclusively that they must be kept well painted or they will deteriorate more rapidly than wooden cars. Cases have been noticed where the doors and window frames which were made of pressed steel shapes, have begun to rust badly within two or three years and for this reason the Pullman Company and some railroads have returned to the use of wooden window sash in their more recent equipment. Also some of the railroads that used metal doors on their first steel passenger train cars found so many objections to them that they have been discarded and wooden doors used in the later cars. The parts of steel passenger cars which start first to rust are the roofs and the moldings or joints between the sheets at the clerestories and eaves, and there can be no doubt about the importance of keeping these parts well painted.

CONCLUSIONS

First.—The average age of steel gondola and hopper cars will probably be about 16 years, judging by the records of those cars which have already reached their limit of life.

Second.—The depreciation of steel gondola and hopper cars should be calculated at about five per cent.

Third.—It will pay to keep steel cars well painted on ac-

count of preserving their strength and improving their appearance and extending their life.

Since the notes and photographs used for this article were made, there was presented at the December meeting of the Pittsburg Railway Club a paper on "The Life of a Steel Freight Car,"* by S. Lynn, master car builder of the Pittsburg & Lake Erie and it is interesting to note that the points mentioned in his paper as well as those brought out in the discussion, agree in most of the essential facts with the observations and conclusions contained in this article. Two statements made in the discussion are especially worth quoting, namely:

"If the steel car was given reasonable treatment and repairs made when needed, and repainted when the steel became exposed to the weather, the renewing of some of the parts would not become necessary for a longer period than is now the case."

"One of the most important things determining the life of a steel car is the question of maintenance. If you spend the right amount of money at the right time, you can get prolonged life and service."

CAR FOREMAN'S RESPONSIBILITY FOR AIR BRAKE CONDITIONS†

BY LAWRENCE WILCOX
Mechanical Expert, Westinghouse Air Brake Company

The value and importance of air brakes as a factor in railroad operation are universally recognized. In fact no other single factor has done as much to increase train carrying capacity, reduce ton-mile costs, shorten train schedules, make high speeds safe and limit the loss and damage claims, as the air brake. Notwithstanding this, it is impossible to handle, with the proper and desired degree of safety and economy, the thousands of trains that make up the daily schedule of our railroads without having the air brake in good operative condition. There are certain definite functions which the brake is designed to perform; whether it performs these functions properly depends upon the manner of its installation, maintenance, and manipulation.

Through the co-operation of the railroad companies and the manufacturers the brake installations on modern cars are, as a rule, satisfactory. However, even with a well designed brake properly installed, the railroad cannot without good maintenance and manipulation get the most out of its investment. Air brakes cannot be operated in a manner to produce the desired smooth and safe train operation unless they are properly maintained; therefore, as the latter depends almost wholly upon the knowledge and ability of the car foreman, his position is indeed an important one, and the effects of his success or failure are far reaching. The car foreman should know the conditions of the air brakes on the cars that come under his jurisdiction; that the men he employs to do air brake work are competent and conversant with the rules and instructions affecting them, and should see that the air brake work performed is of proper character, quality and quantity. He should have a good working knowledge of air brakes. That does not necessarily mean that he must be able to trace the course of the air through the valves, or know the number, size or location of the ports and passages, but his knowledge should be of such character and extent as will enable him to determine when a brake is in good working order.

Brakes should be tested with a service reduction at the proper rate to insure the condition of the brake being such that it will apply and remain applied when placed in the train. There is no economy in re-applying triple valve gaskets that are hard, cracked or sufficiently disfigured that they are likely to cause leaks. An angle cock, that points straight down or toward the outside of the track instead of toward the center, or that is not located according to the M. C. B. Standard, will cause brake pipe leakage at hose couplings and the bending and straining of the air hose which will result in their rapid deterioration. Piping that is not properly clamped will cause leaky pipe joints, broken pipes and shifting of angle cocks to wrong location. A brake cylinder and auxiliary reservoir not held rigidly will cause broken pipes and leakage at the pipe joints. Brake cylinders and auxiliary reservoirs which do not have a bearing on their supporting brackets adjacent to the bolt holes, will be distorted and strained when the bolts are tightened, which is likely to cause cylinder leakage or fracture the castings. Cars leaving repair tracks with defective and porous hose are a cause of excessive brake pipe leakage, trouble on the road and are often the cause of expensive accidents. The application of levers of improper dimensions and proportions causes brake rigging failures, slid-flat wheels, improper and unequal braking power, and is detrimental to train handling.

Changing brake shoes without re-adjusting the piston travel to between 7 in. and 8 in. is often the direct cause of slid-flat wheels, break-in-twos, shocks in trains, and prevents proper manipulation of the train. Permitting passenger equipment cars to leave terminals with automatic adjusters at, or near their maximum take-up position, will prevent a valuable device performing its functions, and therefore prevent its assistance toward proper manipulation. Permitting a car to leave the shops and repair tracks without blowing out the brake pipe is not giving the triple valve on that car, or on other cars in train, a fair show. Applying triple valves to cars without seeing that the branch pipe strainers are inserted and in good condition, and failure to clean dirt collectors at proper intervals, deprives the triple valves of the protection due them.

An egg-shaped expander ring applied to a brake cylinder will cause the brake to be inefficient almost immediately after cleaning and will soon wear the packing leather through at point where it bears heaviest against the cylinder wall. When this occurs the brake is inoperative, necessitating an additional expenditure of labor and material. A car, which leaves a repair track without having the retaining valve and piping tested, stands a good chance of being set out for air brake work, if required to operate under grade conditions. Testing a retaining valve without ascertaining that both exhaust ports are open, is inviting slid-flat and brake burnt wheels. These few illustrations will convey some idea of the importance and value of the car foreman, who properly supervises air brake work.

The car foreman should co-operate with, and obtain all the assistance and instructions possible from the air brake instructor, and encourage the men under him to do likewise. This interchange of ideas will result in mutual benefit and education to the car foreman, the air brake repair man and the air brake instructor. The car foreman must be held directly responsible for knowing absolutely that the man who is actually doing the job is turning out a product of proper character, quality and quantity. The utmost skill and judgment that can be exercised by the man who manipulates the brakes can only partially compensate for brake equipment carelessly tested and poorly maintained.

Guarding Overhead Belts.—Overhead driving belts, and, in fact, all overhead belts, should be so guarded as to prevent their falling on workmen in case of breakage. Recently a workman was badly injured by a driving belt because it was not properly protected, and investigation in the same shop showed five other belts lacking guards. While the falling of a belt may not be a life-and-death matter, it may easily result in a serious accident.—American Machinist.

*For an abstract of this paper see the *Railway Mechanical Engineer* for January, 1916, page 29.

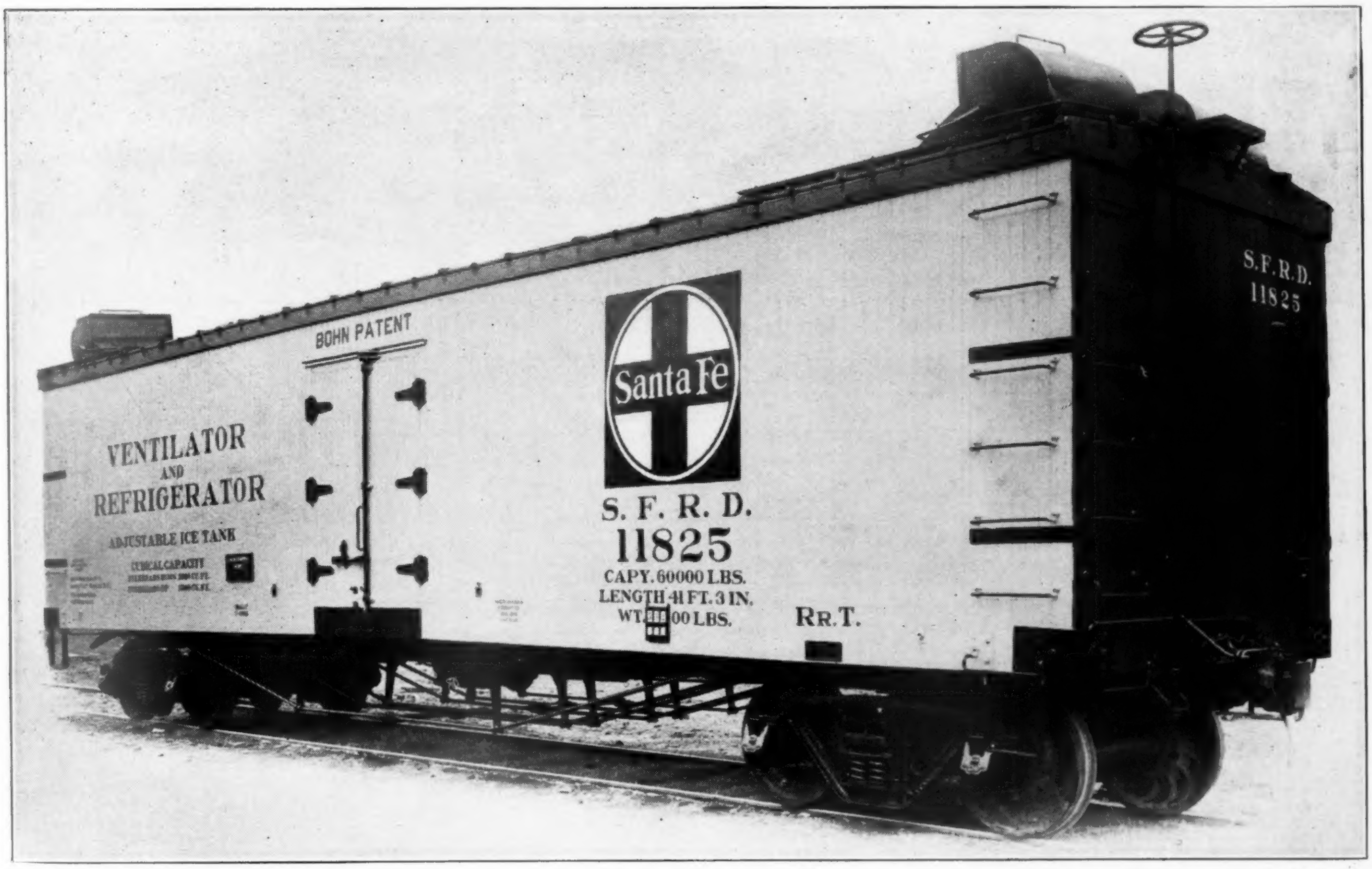
†Abstract of paper presented at the February meeting of the Car Foremen's Association of Chicago.

Santa Fe Refrigerator Cars

Special Features Are the Ventilators, Draining Attachments and the Application of the Insulation

During the past year the Atchison, Topeka & Santa Fe has purchased 500 refrigerator cars which embody several interesting features in their design. They are of wooden construction, with metal draft members in the underframe, and steel carlines; each weighs 52,000 lb. and has a capacity of 60,000 lb. They are equipped with collapsible bulkheads, which increases the cubical capacity some 15 to 20 per cent when not loaded with refrigerated freight. Complete plans and specifications were prepared by the railway company, and the cars were built by the American Car & Foundry Company. The following are the general dimensions:

Length over end sills	41 ft. 3 in.
Width over end sills	9 ft. 1¾ in.
Width at eaves	9 ft. 6⅞ in.
Width, inside	8 ft. 2¾ in.
Height, inside, clear space	7 ft. 3 in.



A. T. & S. F. Refrigerator Car

Wheel base, total	36 ft. 3 in.
Wheel base, truck	5 ft. 4 in.
Length inside, bulkheads up	39 ft. 2¾ in.
Length inside, bulkheads down	33 ft. 2¼ in.
Height, top of running boards	12 ft. 7 7/16 in.
Height, top of brake shaft	14 ft. 1⅛ in.

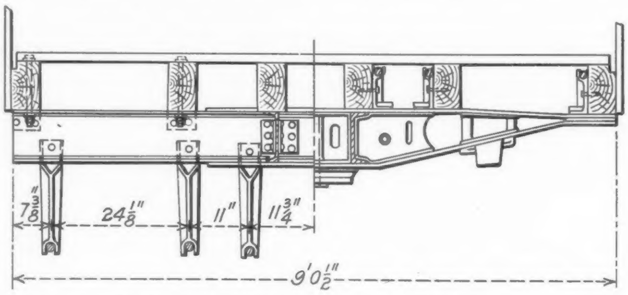
The underframe is of the truss rod type, this being the standard of the road for refrigerator cars. There are six 5-in. by 9-in. longitudinal sills, the center sills being reinforced by two 9-in., 21.5-lb. channels which serve as the draft members. The end sills consist of two oak timbers 4 in. by 10⅝ in. by 9 ft. 1¾ in. bolted together with six ⅝-in. bolts and mortised to receive the longitudinal sill-pockets. All the sills are covered on top, and the side sills are covered partly on the outside with Waterdyke felt. The tie beams supporting the truss rod queen posts are 9 in., 15-lb. channels, which are secured to the draft channels by top and bottom gusset plates. There are six truss rods, 1¼ in. in diameter. The body bolsters consist of ¾-in. by 10-in. top and bottom cover plates riveted to malleable iron fillers and to the draft channels, and bolted to the longitudinal sills. The body side bearings are pressed steel and slide on roller truck side bearings. Drop-forged body center plates applied with 11/16-in. shims are riveted to the bolster with ⅞-in. rivets.

The framing is made up of 2-in. by 5-in. side posts and braces, 3-in. by 4⅜-in. end posts and braces, 4-in. by 6-in. corner posts, 5¾-in. by 5½-in. door posts, and 24 vertical ⅝-in. tie rods. There are two belt rails at the sides and ends, located about 16½ in. and 4 ft. 4½ in. above the floor. The cripple belt rails which extend between the posts and braces are 2 in. by 5 in. The belt rail liners, which are continuous pieces, are 1¾ in. by 2½ in. The side and end plates are 5½ in. by 8 in. and 3 in. by 13 in. respectively. The outside sheathing and the lining are 13/16 in. thick, and the flooring is 1⅝ in. thick. The roof structure consists of two purlins 3⅜ in. by 4½ in., a 3½-in. by 5½-in. ridge pole, six steel carlines of 4-in., 9.5-lb., I-beam section, and 13 wood carlines. The I-beam carlines are cut and shaped as indicated in the drawings. This type of carline is peculiar to Santa Fe freight cars and provides a substantial support for the superstructure. The ceiling is ⅝ in. thick, and the roof 13/16 in. thick. The Standard Rail-

way Equipment Company's outside flexible metal roof is used.

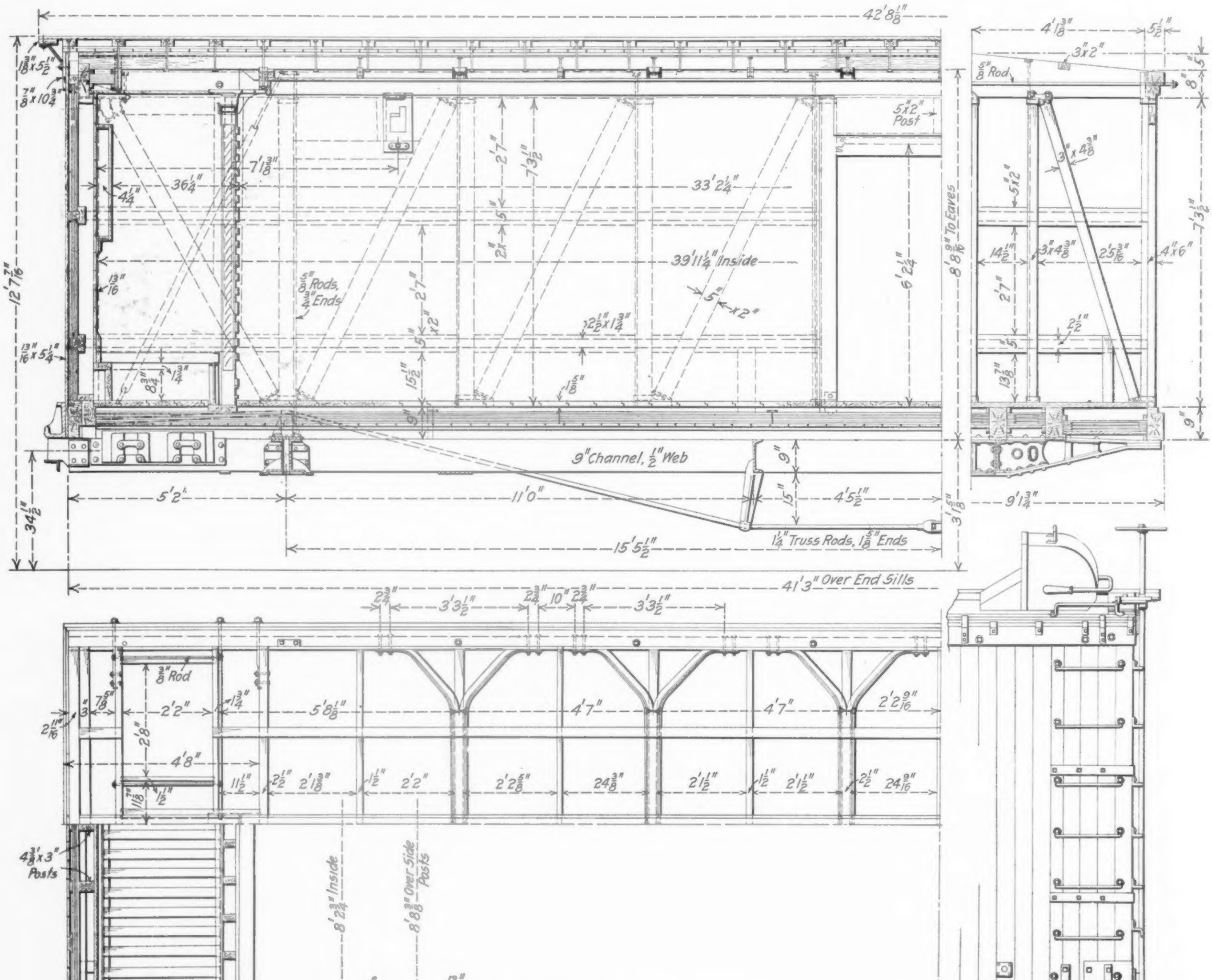
An interesting feature in the insulation of these cars is the method in which it is applied. Four layers of ½-in. Flaxlinum are applied, one against the other, with no air space between them. Air spaces are provided on either side of the insulation, however, the space between the outside sheathing and the insulation being about ¾ in. wide, and that between the lining and the insulation 2 in. wide. This construction is easier to build than one in which the air spaces are provided between the layers of insulation, and it is expected that it will stand up better in service. It also simplifies the making of any repairs that may become necessary.

The side sills are gained out 1½ in. by 1 11/16 in. to receive two layers of the Flaxlinum. The other two layers start from the floor. All four layers are waterproofed up to a point 1½ in. above the floor, and the entire length of the sides, except that the space between the insulation and the inside sheathing is 4⅜ in. wide. One layer of the insulation completely surrounds the car, passing over the corner



Half-Section Through the Underframe

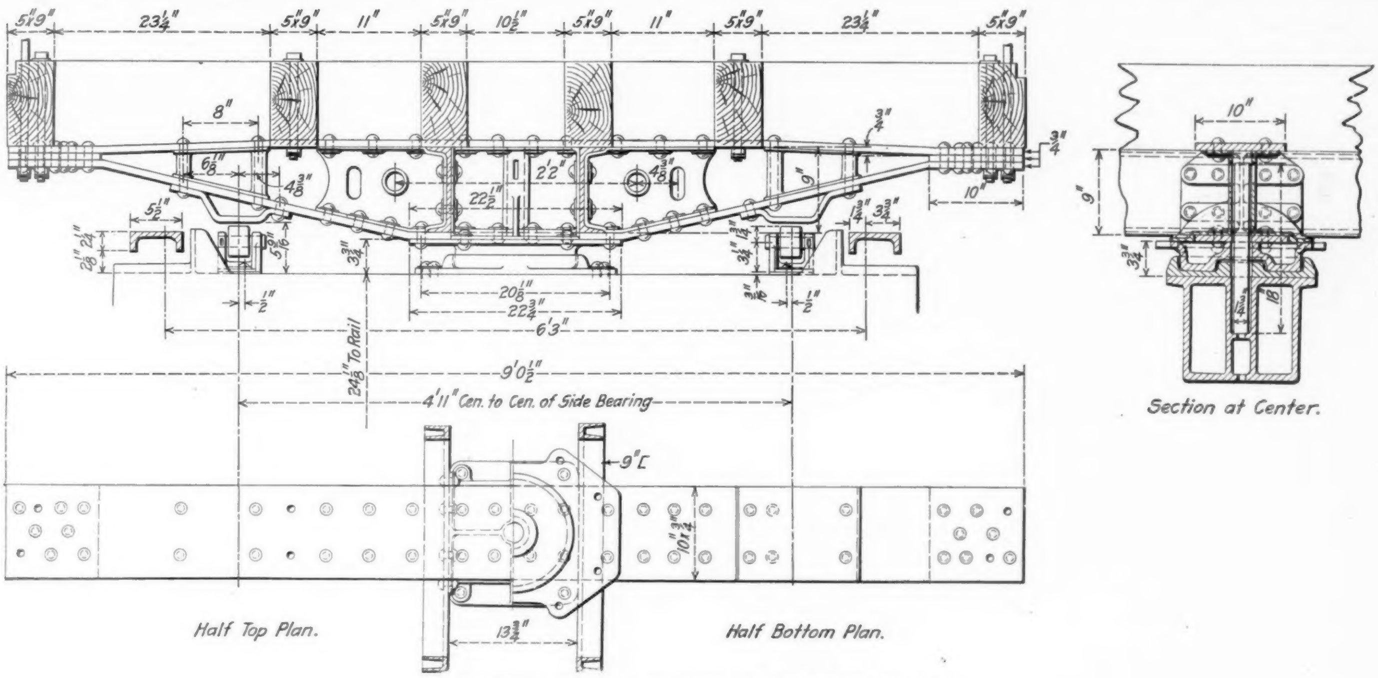
posts. In the roof there is one layer that completely covers the car, passing over the purlins and carlines. The other



Plans and Elevations of the Santa Fe Refrigerator Car

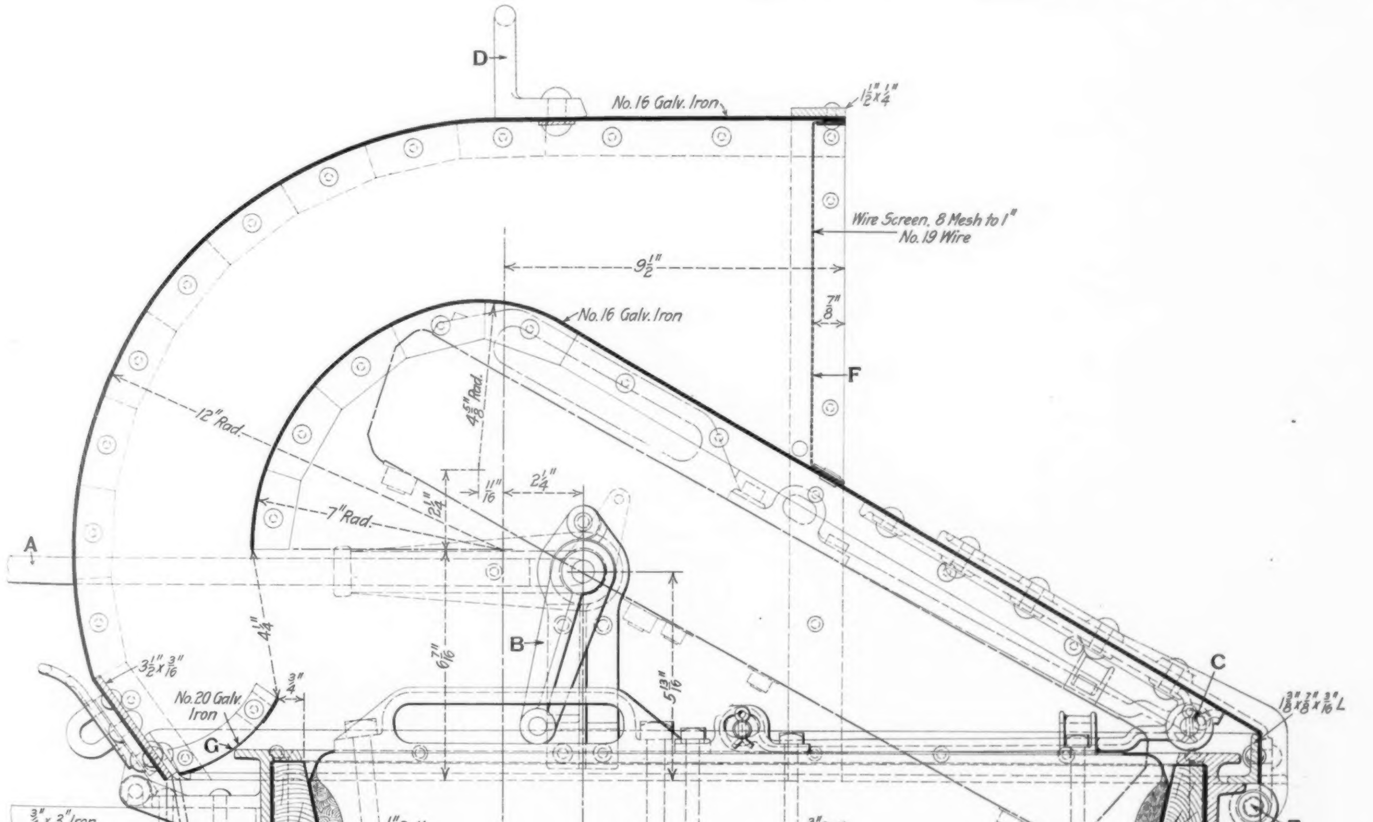
exposed surfaces of the outside and inside layers is covered with three-ply waterproofing paper. The outside layer of Flaxlinum extends in continuous pieces from the side sill to the side plate; the other three are intercepted by the belt rail liners. The side plate is gained out to receive all four leyers. The application at the ends is similar to that of the three layers pass between the hatches and the third carline, between the third and the middle carlines, from each end, and between the purlins. This insulation is placed directly on the false ceiling, which is about 4 in. above the ceiling. There is an air space of ¾ in. between the insulation and the roof boards. The floor is insulated with four layers of

½-in. Flaxlinum cellular blocks supported by a sub-floor. These layers are separated by blocks of ⅜-in. Flaxlinum. The insulation extends between the longitudinal sills of the car, and is entirely enclosed in waterproof material.

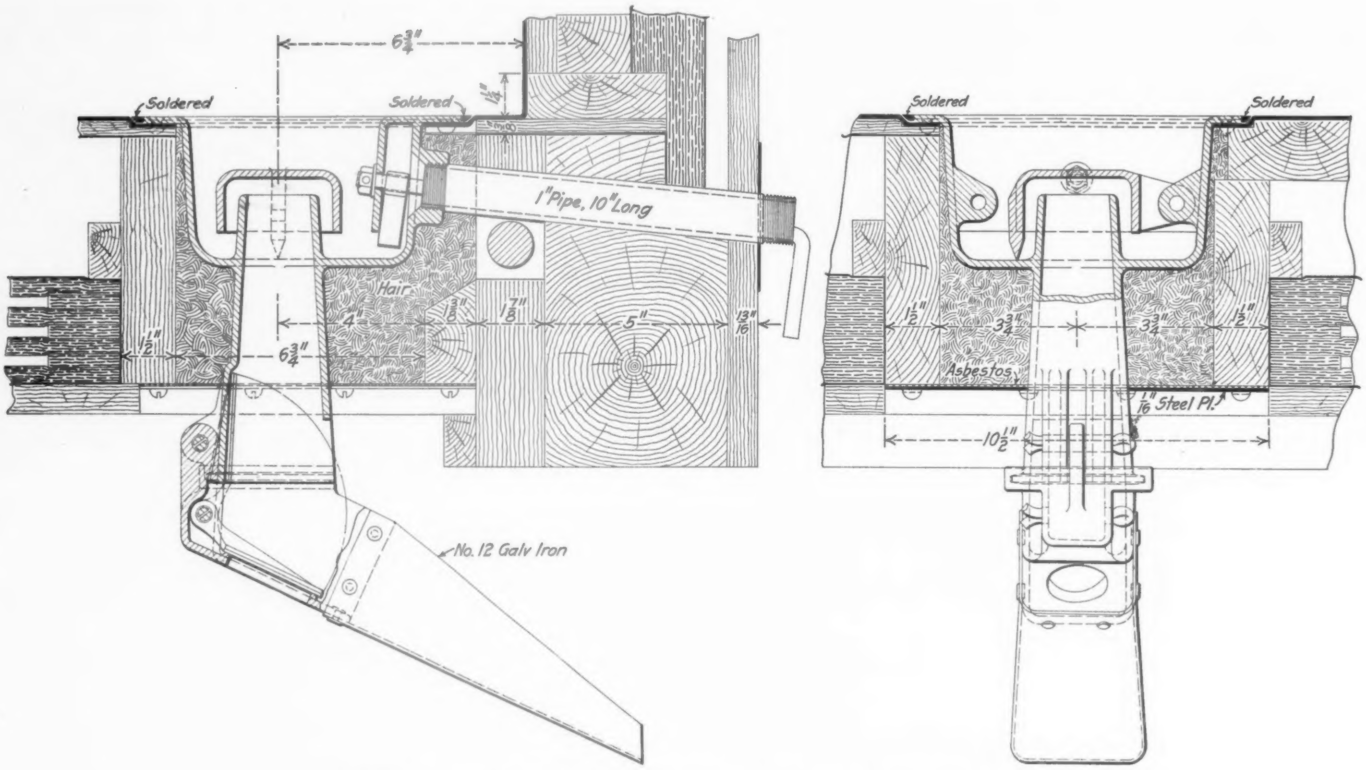


Body Bolster for the Santa Fe Refrigerator Car

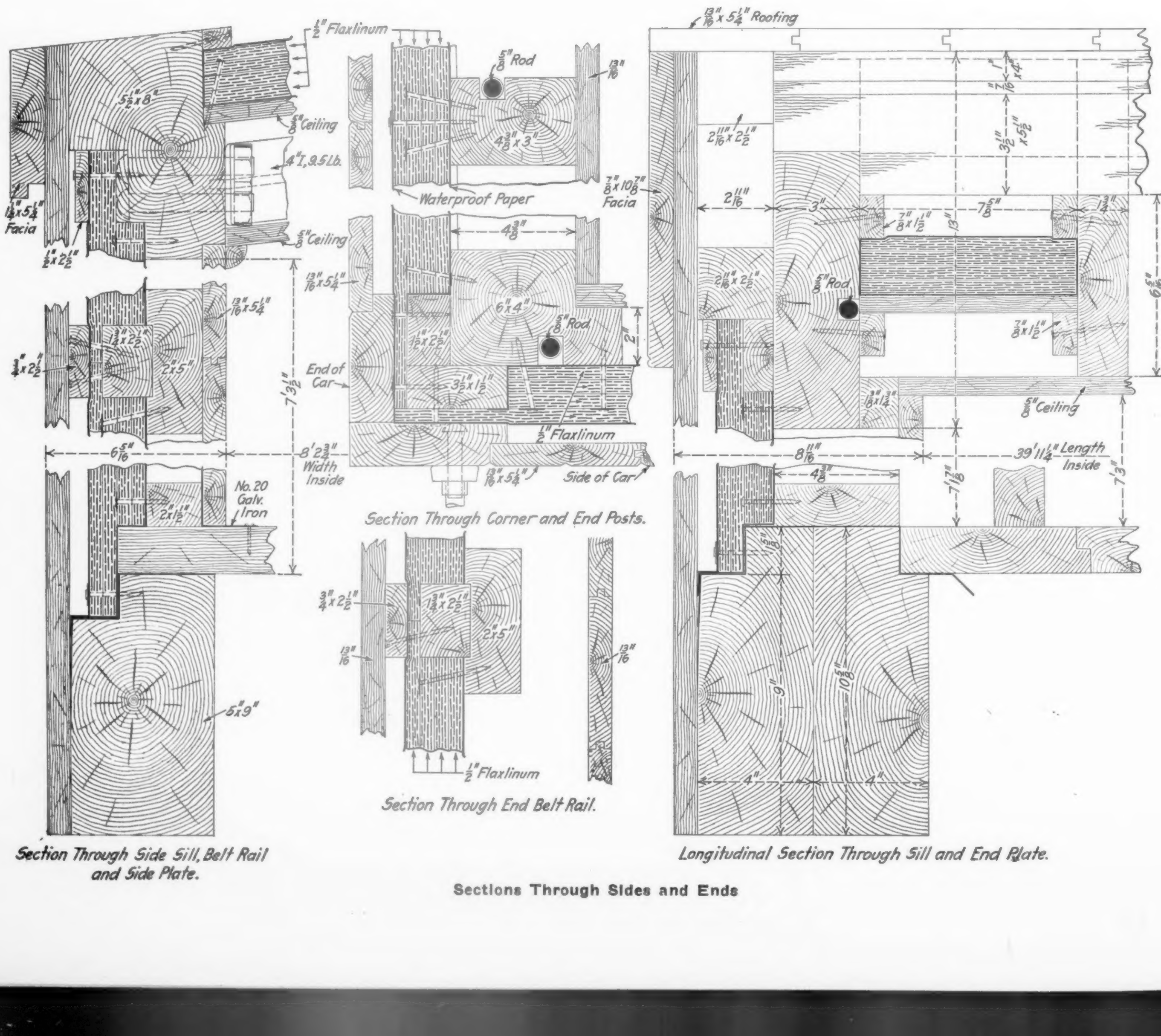
On account of the sudden changes in temperature encountered by the cars coming from the western coast, it is necessary frequently to open and close the hatches when carrying a load under ventilation. To do this expediently



Santa Fe Refrigerator Car Ventilator

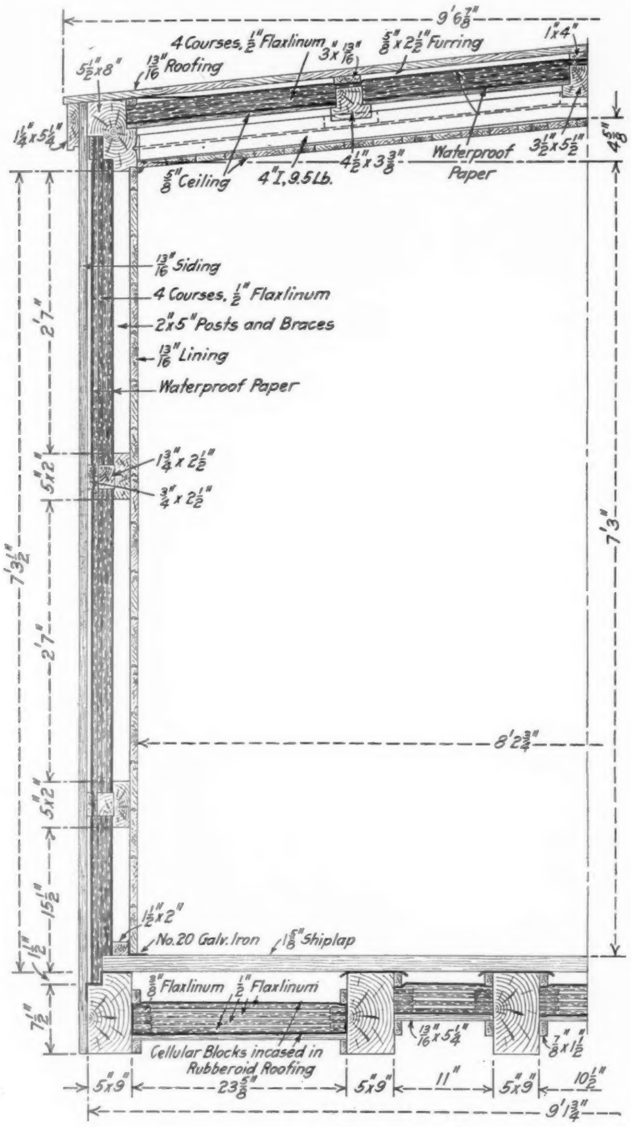


Malleable Iron Double Trap and Drain; Santa Fe Refrigerator Car



Sections Through Sides and Ends

the arrangement shown in one of the drawings has been devised by the engineer of car construction. The rod *A*, outside of the ventilator casing, operates the lever *B*, which, as the rod *A* is moved through 180 deg., raises the hatch to



Half-Section of the Santa Fe Refrigerator Car

the open position shown by the dotted lines. The hatch is hinged at *C*, which is attached to the casing of the ventilator. When it is desired to ice the car the whole ventilator is raised by the handle *D* about the hinge *E*, the hatch lifting with the ventilator casing. A wire screen *F* is provided at the opening of the ventilators, and a deflector *G* is added to catch any dirt and water that passes through the screen, permitting it to pass through an opening at the bottom of the deflector. The hatchway is substantially reinforced by a malleable iron frame cast in four pieces and joined at the corners, which contains the hinge for the ventilator. Each car is equipped with four of these ventilators, one at each corner.

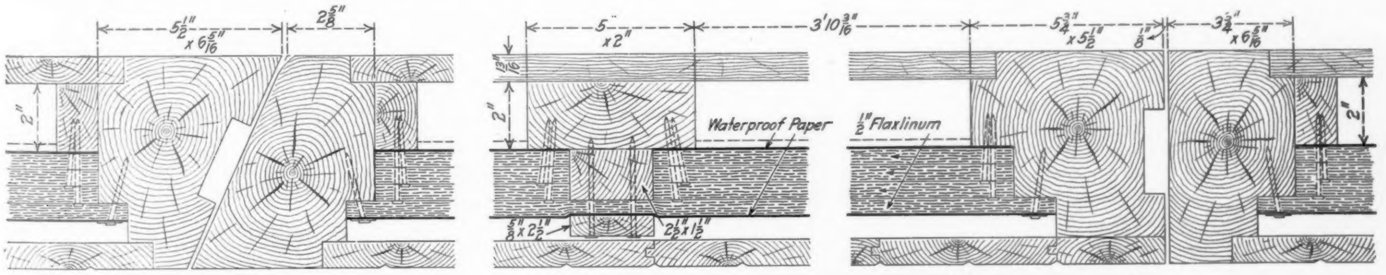
The traps and drains in the ice boxes are of special interest. In addition to the inverted cup drain, a 1-in. pipe runs from the drain basin to the outside of the car, the drawings clearly showing this arrangement. The opening of the pipe drain is above the edge of the inverted cup, and the pipe itself is water sealed by the rib in the drain basin, the car thus always being water sealed. The purpose of this pipe is to carry the drain water well outside the track; as will be noted, the water will flow from the pipe before it will flow through the regular drain. The rod passing through this pipe, with the arm on the end, is placed there to permit the dislodging of any obstruction that may form at the opening of the pipe. The inverted cup is so built that it will fall by gravity to the closed position whenever raised. The space surrounding the cup is completely filled with hair insulation.

Among the specialties used in the construction of these cars are the following: Miner friction draft gear, type A-19-B; Creco brake beams; Andrews cast steel truck side frames; Standard Car Truck Company's roller side bearings and lateral motion device; Bohn collapsible bulkheads, and the Standard Railway Equipment Company's outside flexible metal roof.

FREIGHT CAR CONSTRUCTION MAINTENANCE AND ABUSE*

BY C. J. WYMER
General Car Foreman, Belt Railway, Chicago

All departments of a railroad are more or less affected by the condition of freight cars, and it is our purpose to point out some of the undesirable effects as the result of improper construction, maintenance and abuse. There are several important features to keep in mind in designing new equipment in order to combine economy and efficiency in such a way as to utilize the money expended with the best possible result. It is desirable to use the minimum amount of material possible, without sacrificing efficiency, as an unnecessary pound of metal or foot of lumber here and there not only adds to the initial cost and subsequent maintenance, but adds to the cost of transporting the vehicle. Each pound of weight contributes its proportion to this expense in the way of fuel consumption, wear on locomotives, tracks, and the vehicle itself. When considered individually the result is comparatively small, but when several hundred pounds are multiplied by a great number of cars and again by several years of life, it assumes large dimensions. While this is an economy deserving of careful consideration, there is also danger in employing its use to the extent that it ceases to be an economy only so far as the initial cost is concerned, and proves a burden of expense in future maintenance, accidents, delays, loss and damage to freight, etc., which more than offset the first advantage gained. Observation demonstrates that this



Section Through Beveled Door Stiles. Section Through Door Stile, Door Post and Side Post.

Section Through Door Stiles, Door Post and Side Post

*Abstract of paper presented at the January meeting of the Car Foremen's Association of Chicago.

condition not infrequently exists either from an overzealous desire to reduce initial cost or lack of definite knowledge of requirements.

Having indicated some of the features to be avoided, as well as some features which should be favored, the thought naturally arises, How can the problem best be solved? We believe the remedy lies in standardizing designs and construction as rapidly as consistent, with means of enforcing the use of these standards. Standardizing means the elimination of the one man's opinion, from which most of our trouble comes, and insures thorough investigation by the best talent. Standardizing has several valuable features, a most valuable one being a reduction in the amount of material required for repairs. Material stocks are now much larger than would be necessary except for the various designs of more or less equal merit, which, if converted into cash and expended for the purchase of live material and employment of labor for repairing cars, would have a far-reaching effect toward better maintenance. It may be argued that standardizing will throttle invention and improvement, but we cannot concur in this thought. We believe it would automatically insure an improvement in construction and would eliminate many ideas of questionable merit. There should be sufficient elasticity to permit the incorporation of improvements of sufficient merit to warrant such action, but alleged improvements which are weighed in the balance and found wanting should not be entitled to recognition.

Having considered some features of construction, we desire to discuss some of the advantages of a better maintenance of equipment. It cannot be consistently argued that cars should be maintained in perfect condition. Any attempt to do so would mean much loss in both material and labor through renewal of parts suitable for further service; it would also mean withdrawing cars from service when they should be used. There is a degree of efficiency in maintenance necessary to keep the car in a reasonably safe condition for handling, and for protection to the commodity handled, also to prolong the life of the car at a minimum cost of maintenance during its existence, which in the end means the maximum of service. It is a well-known fact that many cars are expected to perform the service originally intended for them, which are wholly unfit to meet the requirements, and should be withdrawn from service until placed in a safe and serviceable condition. I am of the opinion that there are several reasons which contribute to this condition. One is poor design, resulting in cars becoming disabled and inefficient long before ordinary usage should reduce them to this condition. Another is inadequate facilities to meet the requirements for repairs in districts where large numbers of cars are required, with the result that the demand forces into service cars which should have repairs. The facilities provided have not kept pace with the increased demand for service, neither in capacity nor in efficiency of methods. Overtaxed facilities and lack of labor-saving methods in many instances prevent needed repairs being made. The period of service performed by these cars is only of short duration, and they return again for repairs in worse condition than before, while, if suitable attention had been given in the first instance, the cost in the end would have been less and the service performed by the car would have been much greater. It is not infrequent to see new end sills and draft timbers applied to worn-out draft sills, and numerous other repairs made in a similar manner, which can only mean that the same performance must soon be repeated. Greater uniformity in construction would insure a larger output at less cost, as suitable material would be more readily available and workmen becoming familiar with similar constructions can perform the work with greater dispatch.

Periodically reducing and reorganizing forces prevents economical repairs. Each time a shop is organized for extensive repairs it means the introduction of a large percentage of new labor, which takes time to become efficient, and the money thus expended would keep a well organized force of efficient help permanently employed, producing a larger volume of work. If of necessity the forces are to be larger at certain times than others, the greatest result to be obtained for the money expended can be accomplished by reducing the force at seasons of the year when weather conditions are most favorable; there is a considerable percentage of loss in labor when there is no protection from the elements during the winter season.

It is also a good business proposition to repair the cars and get them in serviceable condition when they are idle and not needed in service. Good, serviceable cars mean so much in reducing other expenses resulting from cars in poor condition that there seems to be no good reason why they should not be maintained in an efficient, serviceable condition. A load placed in a defective car most generally means delayed movement, added expense in transporting, claims for damage, and often dissatisfied customers. An accident resulting from a bad car often means damage and destruction to other good cars and delay to the entire traffic of the railroad.

Greater uniformity and efficiency in construction, proper maintenance of equipment at all times, and adequate facilities for making repairs means economical maintenance of equipment and tracks, reduction of claims, reduced operating expenses, fewer blasts of the wrecking whistle, increased average mileage per car, more efficient service and a better satisfied investor and public.

We desire to introduce a thought which may be considered a little foreign to the subject, but so closely related to it that to us it does not seem out of place, as it indicates a now large expense, which, in our opinion, could be greatly reduced, and the money diverted to better maintenance of old or the purchase of new equipment. We refer to that feature of the M. C. B. Rules making a distinction between owners and delivering line defects. There is a vast army of men employed by the railroads whose principal duty is to make records as a means of protection against so-called delivering line defects, and attach greater importance to a few sheathing boards slightly raked, that may not affect the service of the car, than they do to a worn wheel or numerous other defects, endangering the safety of the equipment, lading and human life. We lay no censure at the doors of the men who are performing this service, as we are constantly teaching them that it is almost a crime to overlook a defect involving a defect card, which often has a value of less than a dollar. Why not take a businesslike view of the situation and cease spending two dollars in an effort to save one. Do away with the delivering line defects, inspect for safety of operation and lading only; educate these men along the lines of endeavor which have a real value, and cease to follow illusions. A vast amount of this labor expense could be diverted to the purchase of material and repairing defects which are a menace to safety, instead of finding and making a record of a lot of immaterial defects at the expense of more important ones. The reduction in expense would continue down through the offices and result in saving a large labor and stationery expense there.

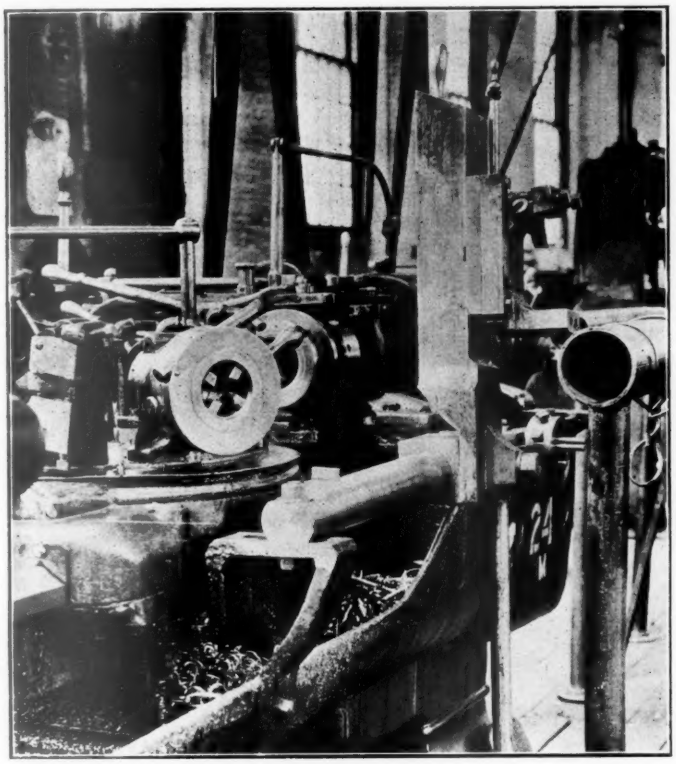
To those who sometimes advance the argument that penalties are necessary against the handling line to promote the proper care of equipment, we would say that, in our opinion, there is no relation between the thoughts; the employees misusing a car have no knowledge of these penalties and take no notice of the ownership as indicated by the initials on a car. They will damage a car owned by the railroad employing them as readily as they will one owned by a foreign line. They could hardly make this distinction if they desired, on account of the mixed manner of handling cars.

It is our belief that the railroads are spending more money annually in labor and stationery in protecting themselves against these defects than it would cost to make the repairs. This does not mean the use of the owners' car without just compensation; that can be handled more economically on a rental basis than by rental and defect rules combined.

SHOP PRACTICE

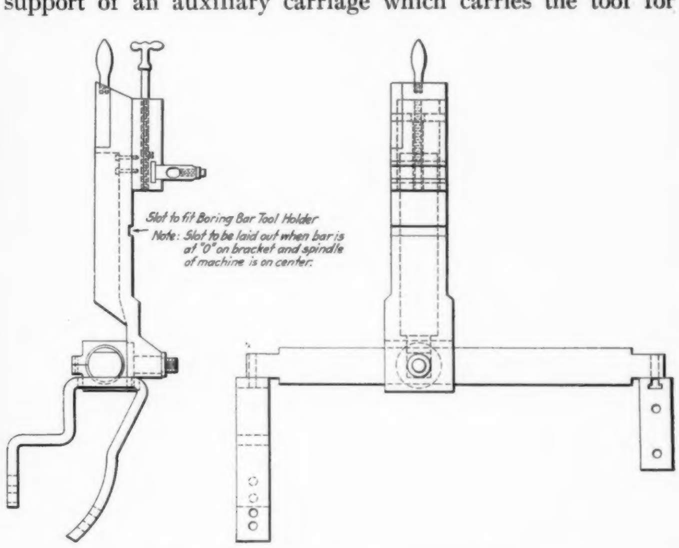
TAPER ATTACHMENT FOR TURRET LATHES

At the Dale street (St. Paul) shops of the Great Northern a taper attachment made in the shop has been applied to one of the Jones & Lawson turret lathes and has given good



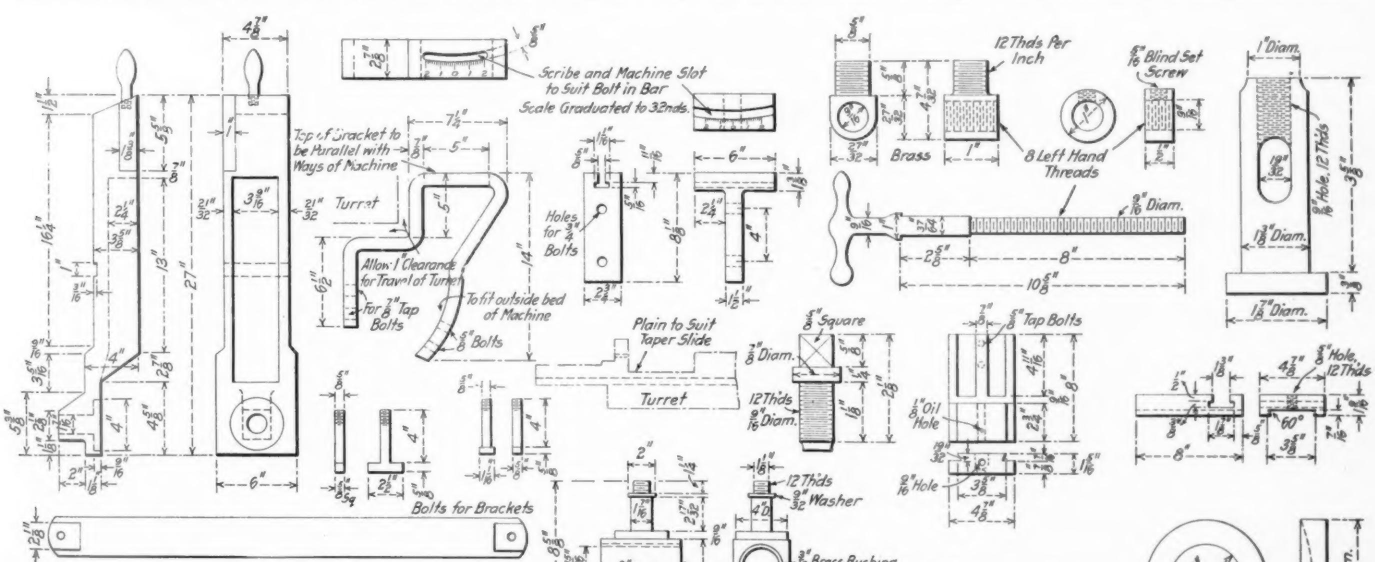
Rear View of Jones & Lamson Turret Lathe Showing the Taper Attachment

results. An adjustable guide bar is attached to substantial brackets on the back of the lathe, as shown in the illustrations, the top surfaces of these brackets being planed parallel to the ways of the machine. Both ends of the guide bar are marked with gaging points directly below the center of the bar, which register on scales graduated to 1/32 in., laid off on both of the bracket supports. The distance between the gaging points on the bar is exactly 3 ft., and the slots in the supports, through which pass the bolts holding the guide bar, are cut to correspond to this diameter. On the guide bar slides the back support of an auxiliary carriage which carries the tool for



Turret Attachment for Jones & Lamson Turret Lathe

cutting the taper. This slide consists of a $4\frac{1}{8}$-in. by 6-in. block, which is split at the bottom and bored out to receive a 3/16-in. brass bushing. The auxiliary carriage is bolted direct to the block, being recessed to fit over a bearing on the block 4 in. in diameter and 9/16 in. high. This bearing is made large to provide a substantial anchorage for the carriage. The front end of the carriage rests in a slot planed out of the turret casting. This slot is of substantial dimen-



Details of the Taper Attachment for Turret Lathes

sion and by it only is the auxiliary tool carriage moved longitudinally. The auxiliary carriage itself is made from a bar 4 in. by 6 in., with a boss 2 in. high at the back end for receiving the bolt in the sliding block. The tool slide is of ordinary construction.

To cut a taper on the work the guide bar at the back is set at the taper desired, the auxiliary tool carriage is placed in the slot in the turret and the work fed out through the head of the machine to the proper distance, and the cuts taken with the tool on the auxiliary carriage. The adjustments are easily made and this attachment has been found very serviceable. When the taper attachment is not in use it is raised to a vertical position and rests on a bar or a support attached to the floor, as indicated in the photograph.

NEVER SLIGHT A JOB*

BY JOHN V. LeCOMPTE

Foreman, Mt. Claire Shops, Baltimore & Ohio, Baltimore, Md.

The old safety valve of the locomotive has given way to the pop. Guessing at the speed the train is making has been supplanted by the speed recorder. The carbon tool-steel of a few years ago has given way to high speed steel. On every hand evidences are noted of the supreme effort to attain the highest degree of efficiency.

The apprentice of today has a broader field of preparation than ever in the past; opportunities to attain to a responsible position are open to him. Schools of training are almost at his door, and to those who are in such humble circumstances that they are unable to attend, provision has been made, with instructions free of charge, that will better qualify them for the duties of today and give them an opportunity of acquiring knowledge that will more strongly fortify them for the future. In many of the larger railroad shops where the foreman is unable to give the time necessary to the proper instruction of the apprentice, able men have been appointed as apprentice instructors. These men give all their time to following up the work and instructing the boys as to the proper methods. While it is necessary that every apprentice receive a technical as well as a practical knowledge of the trade he seeks to master, yet personal contact at school and work, showing an interest in his advancement, instructing him as to any irregularity that may develop, will have much influence in the final results obtained.

At no time should an apprentice be led to believe that the task given him to perform is trivial, not demanding his best effort. At the shop school he should be taught that even in the smallest things care and attention should be given that they may be as near perfection as possible. The same holds good in the practical end (the shop). The drill press can be operated accurately and the best work obtained if care is exercised by the operator. The small lathes that are set apart for the first instructions can be operated to turn out good work and no task, no matter how menial, should be considered below any apprentice's dignity. Apprentices should never be instructed to slight any job given them. I believe thoroughly in the old adage as applied to apprentices—"Whatever is worth doing at all is worth doing well."

ANTI-FRICTION BEARINGS FOR SHOP MOTORS

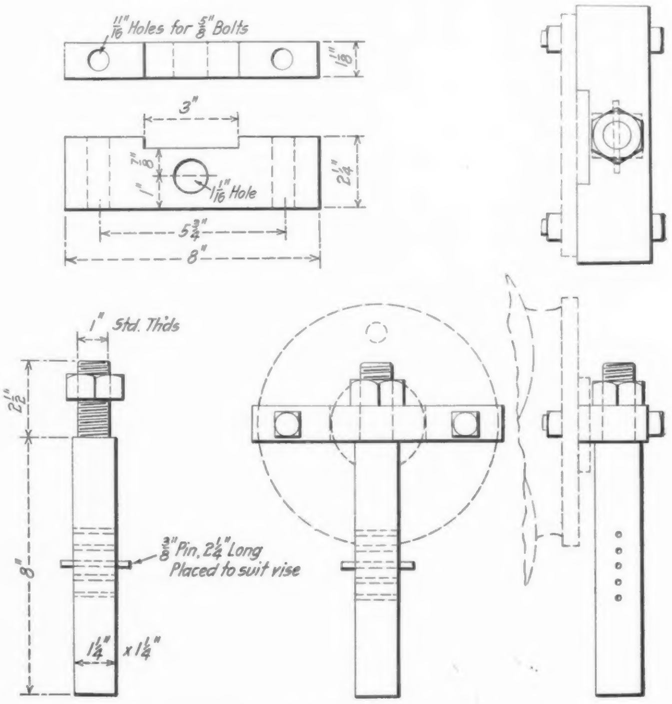
The installation of anti-friction bearings in axle generators, car fans and headlight turbines has proved to be such a marked success that we believe the application of roller or ball bearings to shop motors would also prove to be desirable and advantageous. The induction motor, which is used more than any other type for shop purposes, has, in its small air-gap an inherent weakness which when the ordinary sleeve and ring-oiled bearings are used prevents it from being a fool-proof machine. With the regular ring-oiled sleeve bearings this type of motor may run for months at a time exposed to sawdust, shavings, lime dust, coal dust, etc., without causing a fire and without any wear except at the bearings, because of the absence of a commutator and of other moving contacts, but unless carefully and periodically watched, and lubricated with the proper oil there is danger of the bearings wearing down to such an extent that the rotor will rub against the laminations of the stator, causing serious trouble.

For this reason it seems desirable to equip induction motors with anti-friction bearings and it is reasonable to expect that the results will be as satisfactory as they have been in the case of similar improvements in axle generators, fans and headlight turbines. In addition to minimizing the trouble resulting from the small air-gap there would be the additional advantage of decreasing the number of inspections required per year. This latter feature is of especial importance where the motors are located in places which are hard to reach, such as on the wall or on the roof truss, or on the top of a machine tool frame and other places where the motor is out of sight or difficult to reach and therefore liable to be forgotten or purposely avoided. Another source of trouble with ring-oiled bearings which could be eliminated by the use of anti-friction bearings, is that very often men who have charge of these motors, due to the lack of experience or perhaps because they cannot get the proper oil, sometimes use a heavy oil which prevents the rings from turning.—*Railway Electrical Engineer.*

HOLDING DISTRIBUTING VALVES IN MAKING REPAIRS

BY E. H. WOLF

The device shown in the illustration has been developed for use in a vise to act as a support for distributing valves when they are being repaired. The ⅜-in. pin rests on the top of the vise and the valve is bolted on. By loosening the



Arrangement for Holding Distributing Valves

1-in. nut at the top, the valve can be swung around so as to obtain the best light and otherwise facilitate the work of the machinist on the valve seats and the packing rings. The device can be made of scrap material.

*Entered in the competition on "How Can I Help the Apprentice?" which closed September 1, 1915.

Efficient Enginehouse Organization

Prize Article in Competition Which Closed February 1 Takes Up Methods for Large Terminals

BY E. W. SMITH

The term organization is in many cases a misnomer when applied to the enginehouse. Very often the "enginehouse organization" consists of an individual in overalls who has to be a veritable jack-of-all trades, but who generally "delivers the goods." For that matter, regardless of how large the terminal operations may be or how well arranged is the force, the foreman still remains the chief factor to be considered. A poor foreman will soon disorganize the best organization, while a good foreman will usually make improvements.

In considering the organization of an enginehouse a distinction must be made between an organization for a small plant, handling under 60 engines in 24 hours, and a plant handling over 60 engines in 24 hours. For the smaller enginehouse a good foreman with a crew despatcher, a clerk, an assistant foreman at night, and one or two gang leaders, can handle the situation very well. For a plant handling over 60 engines it is necessary to make use of a well defined organization. The same organization will apply for an enginehouse handling, say 60 engines, as is necessary for an enginehouse handling 300 engines, the only difference being that for a small enginehouse only a skeleton organization is needed, to which must be added additional gangs or men as made necessary by the increased number of engines handled.

The efficient organization must be built up with the idea that the operation of an enginehouse should be similar to a machine, taking in engines from the road at one end and turning them out ready for the road at the other end. Poor gears must necessarily result in a slowing of the output and so long as the inbound engines continue coming, a congestion will result, the effects of which are far reaching. The vital thing to be considered is the reducing of the locomotive hours required in the enginehouse, which from the standpoint of the railroad represent money not earning interest and, in fact, actual losses in addition.

The measure of efficiency can easily be detected by the lapse of time from the arrival of locomotives at the inspection pits to the time that they are available, which should not exceed an average of four hours; and during intervals of power shortage at enginehouses handling a large number of engines, the average time should be reduced even below this figure. As a matter of fact, with the organization explained later the time has been reduced to 1 hr. 40 min. per engine handled.

Not only should the time from "arrival to ready" be closely followed, but the time from "ready to order" should be looked after and, if it is found that this time approximates more than two hours, arrangements should be made to either store engines or send them to the other end of the division. This of course applies to pooled power. During weather above freezing it has been found feasible to store engines at the enginehouse during a temporary power surplus by merely drawing the fire and draining the boiler. Locomotives so stored can be returned to service within three hours.

In discussing an enginehouse organization it is not believed necessary to show any plan or lay-out of tracks, for it is seldom that an ideal lay-out can be applied to the ground upon which the terminal facilities are to be constructed. The organization can always be fitted to the facilities, but the facilities cannot so easily be fitted to the organization.

In building a terminal, care should be taken to see that there is sufficient locomotive storage room between the inspection pits and the entering switch from the yards and that sufficient storage is allowed between the inspection pits and the ashpits, also between the ashpits and the enginehouse proper. Further, the storage sidings should have sufficient capacity for the holding of engines that require only light repairs, such as can be handled on tracks not located over pits, with possibly the exception of sponging or adjusting wedges. A sponging pit should be provided on the storage siding, if possible at the end of one of the storage tracks. A track should be provided adjacent to the ashpits upon which can be placed locomotives that have had the fire drawn for staybolt testing, repairs to grates, blowing and calking flues, and other defects which, while they require the drawing of the fire, can readily be attended to without making it necessary to place the locomotive in the enginehouse. A blower line should be laid along this track to facilitate the firing up.

If the enginehouse is not an integral part of a back shop, a machine and blacksmith shop should be provided. A small flange fire and facilities for safe-ending tubes will also save time and money. The advisability of providing such facilities may be questioned by some authorities, but with them and one or more electrically operated drop tables heavy repairs can be quickly and economically handled.

An enginehouse should be operated to keep engines in service, consequently, if an engine can, within say four days, be given a light class repair at the enginehouse, economy will result. It is not difficult to see that a saving can be made by handling the work in the enginehouse, rather than move the engine to the back shop, and have it await its turn for the erecting shop, even without considering the many small repairs which would be made when not really needed.

The organization outlined in the chart, and commented upon later, obtains at two enginehouses, the one handling on an average of 300 road and yard freight engines daily, located some distance from a back shop; the other an average of 140 passenger engines per day and in itself a part of a back shop. The organizations are almost exactly the same, other than the addition of repair gangs and additional miscellaneous forces and the operation of a small machine, blacksmith, and tube shop at the larger terminal.

The day foreman has charge of the entire operation, the night foreman performs the same duties, reporting to the day foreman. The first assistant foreman, in both the day and night organization, looks after the general operation, with special regard to the movement of engines through the terminal. As shown by the chart, his direct supervision is over the class of employees having to do with the work of general preparation of the locomotives.

The second assistant foremen, both day and night, are in charge of repairs as carried on in the enginehouse proper. The foremen, day and night, exercise general supervision over the plant.

Starting with the inspection pits, which the writer feels is the most important feature, if one is more important than another, we will follow the progress of the locomotive through the terminal.

INSPECTION PITS

The gang leader in charge of the inspection pits should be a man thoroughly capable of deciding just what defects reported by the enginemen should be repaired and just what light repairs, such as tightening nuts, renewing brake shoes, etc., should be handled at the inspection pits without caus-

ing a congestion between the inspection pits and the yard switch.

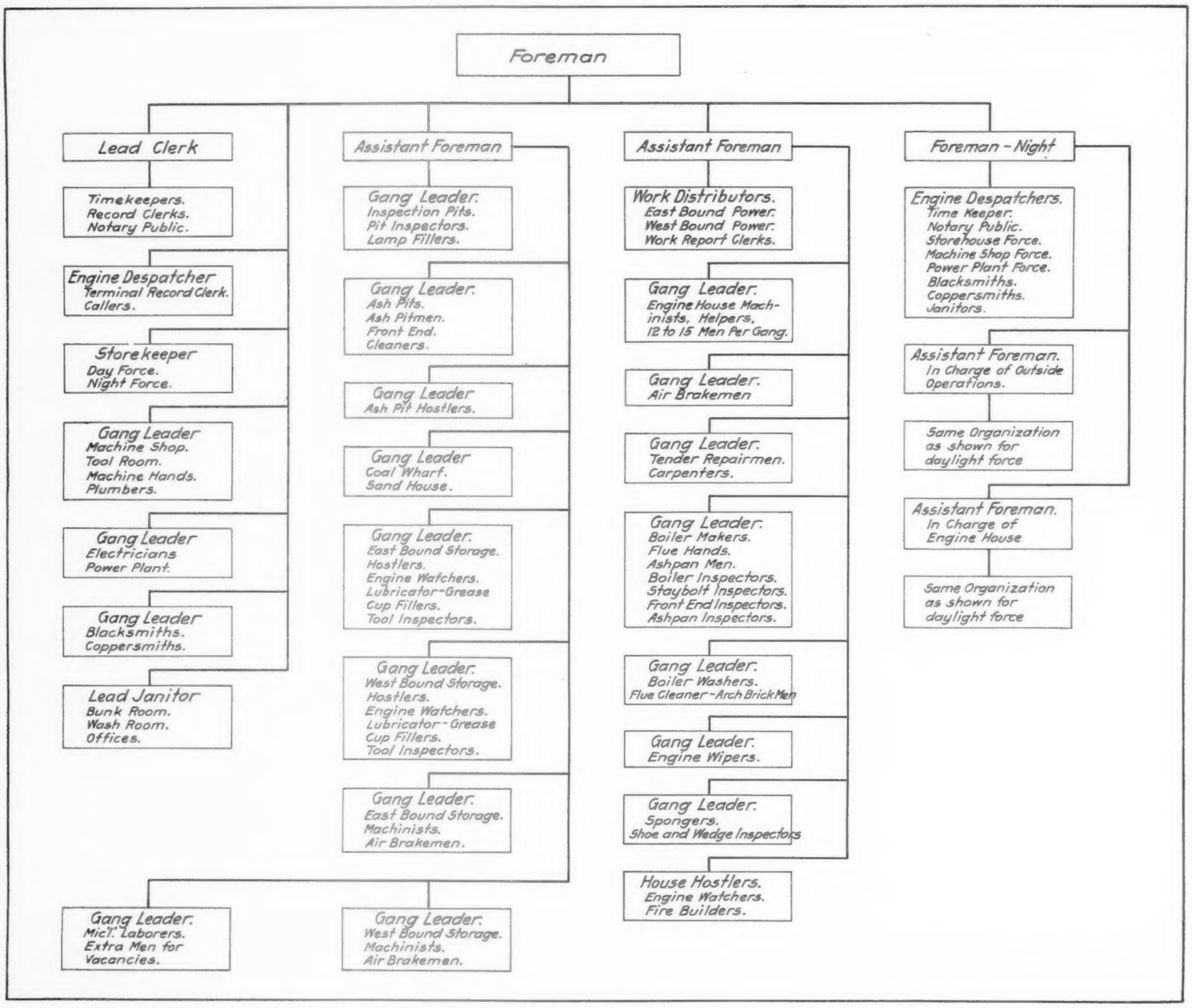
The inspectors should be arranged in gangs, a gang to each pit, a machinery inspector on each side of the engine, one inspector under the engine and tender, an inspector to cover each side of the tender, a cab inspector, and one outside air-brake inspector. These inspectors should be instructed to report all defects which should, in their opinion, be repaired, with the exception of such light work as they can handle themselves. After the inspection, the gang leader should immediately go over the forms received from the inspectors and enginemen and report to the work distributors in the enginehouse foreman's office the condition of the locomotive so that the engine despatcher can determine about what time the locomotive can be supplied for a train. The written report should then be transmitted to the foreman's office, preferably by means of an air tube. The fire door or the backhead of the engine should be chalked with a code number to show whether the fire is to be drawn or cleaned, and whether the locomotive is to go to the enginehouse for heavy repairs, to the siding for light repairs, or to the fire-up track adjacent to the ashpit with the fire drawn or cleaned. An important adjunct of the inspection pits is a sufficient supply of the most frequently used light material which can be applied by the inspectors. This material can be charged out and the value prorated on the basis of locomotives handled.

ASHPITS

The ashpits should be in charge of a gang leader who will see that the engines are moved promptly from the inspection pit and that fires are promptly cleaned or drawn as the code marks indicate, the ashpits emptied at the proper times, and that no congestion or slowing up of the locomotive movement occurs around the ashpit. It has been found that the maximum results are obtained by having a hostler clean the fires, take water, sand, etc., and move the engine direct to its destination, either storage siding or house. A stationary gang in charge of a leader drops the ashpans, cleans the front end and ashpits and surroundings.

A gang leader or head hostler should be in charge of the handling of locomotives on the storage siding and he should keep in close touch with the engine despatcher, see that engines are promptly placed from the ashpits and that they are arranged in the proper order for leaving. He should also see that the crews report promptly and that the power is despatched in accordance with the leaving time as furnished by the engine despatcher.

On the storage siding there should be a gang leader of machinists who will have charge of making repairs deemed necessary on locomotives despatched direct from the ashpits to the storage siding. He must be in a position to repair the emergency defects so often reported by enginemen just at leaving time. The inspectors' reports for locomotives sent to



Organization Chart for a Large Enginehouse

the siding direct should be sent from the office through an air tube to the gang leader on the siding. A sponging pit should be provided on the siding, with spongers, in order to quickly handle this class of work.

There should be a gang leader in charge of the coal wharf and sand house, although at smaller terminals this work can usually be looked after by the leader on the ashpits.

OPERATION OF THE ENGINEHOUSE PROPER

Of the two assistant foremen, one should have charge of the repairs to locomotives and the operation of the enginehouse proper. In the organization shown above there are two work distributors, one for the Eastern division power and one for the Western division power, whose duties consist of turning over to the various gang leaders the reported defects forms should then be taken by the work distributor to the respective gang leaders in charge of the repairs. In piece work shops, and if desired in day work shops, the work can of course be copied by clerks on work cards or other standard forms and the cards delivered to the gang leaders in lieu of the work report, which it may be desired to keep in the office.

It has been found that the best way to organize the repair gangs is to make use of a machinist pool leader, this man having with him an experienced helper and a less experienced man who is being developed into a machinist helper. The inexperienced man can be used for securing material and to assist in the handling of heavy parts. This pool arrangement divides the gang leader's force of 12 or 15 men into 4 or 5 sections, each section having a responsible leader who is

BLANK ENGINEHOUSE

Track No.	Loco. No.	Time In House	Fire Out Or In	Time Ordered	Machinist Work Gang No.			Air Brake Work	Tender Work	Sponger Gang	Boiler Work	Boiler Wash	Ready To Fire	Ready to Move Out	Time Out of House	Remarks
					1	2	3									
1																
2																
3																
4																
5																
6																

Blackboard for Keeping Track of the Progress of Locomotive Repairs

to be repaired, follow the progress of the repairs, and report to the engine despatcher the time that locomotives can be ordered for trains.

In order to keep in close touch at all times with the progress being made on repairs, a blackboard, arranged as shown in the engraving, should be provided in the enginehouse. The hostler bringing in an engine should enter the number and the time the engine arrived in the house, stating also whether the fire has been dumped or left in the firebox. This information should be placed in the line corresponding to the track number upon which the locomotive has been placed. The work distributor will place a symbol in the work columns indicating what gang leaders have been given work on the engine, and will also show the time ordered. When work has been completed the gang leader will erase the symbol *X* used to show that he was given work and mark held strictly responsible for the repairs made by his pool. As the work is completed the original work cards or forms should be sent back to the gang leader and finally to the foreman's office for record and file.

In complying with the law effective January 1, 1916, it is felt that the gang leader actually "passing up" work should make proper notation on the original form and that these "passed up" items should be copied on a separate form and filed until the engine is held for boiler wash attention or heavy repairs. If it is not desired to make separate forms, the original forms should be consulted at times of heavy repairs. This of course necessitates filing these forms in a proper filing case by engine number.

The Interstate Commerce Commission requirements as to monthly and annual certification also make necessary a staff of boiler and machinery inspectors. These inspectors should

TERNINAL RECORD
MOVEMENTS OF LOCOMOTIVES AT________ DIVISION
FROM MIDNIGHT TO MIDNIGHT_______ 191____

LOCOMOTIVES ARRIVING

Loco. No.	Division	Kind of Service	Train No.	Engineman	Fireman	Time Crew is Available	Arrived at Terminal	Time from Terminal to Pit Track	Arrived at Pit Track	Time from Pit Track to Engine House	Arrived at Engine House	Time from Arrival at Engine House Until Ready for Service	Time Ready for Service	Remarks

LOCOMOTIVES DEPARTING

Train No.	Time Order Was Placed	Time Ordered for Service	Engineman	Time Reported	Fireman	Time Reported	Time Loco. Left Storage Track	Time Leaving Terminal With Train	Time from Arrival at Pit Track Until Ready for Service	Remarks

Locomotive Terminal Record

O. K. The work distributor will mark *O. K.* for the fire, and *O. K.* to move out, and the outbound hostler will show the time that he departs with the engine.

The reports received in the foreman's office from the inspection pit should be of some convenient form complying with the Interstate Commerce Commission requirements. The work for the various gangs should be reported by the pit inspectors on separate blanks so that the boiler work will appear on one form, the machinist work on another, etc. These be assigned specially to this work and the making out of the forms should be looked after by a clerk who, when possible, should be a notary.

ENGINE DESPATCHING.

The despatching of locomotives, assigning and calling of crews, and the checking of time tables, is in itself a very important part of the work and the engine despatcher should be a man of ability. This man should receive from the trans-

portation department the various requests for power, keep in touch with the power situation through the work distributors, see that the crew boards are properly kept up, that the crews are properly called, and when reporting see that they are given the proper time tables. He should also see that their time tables with general orders and stickers are in the proper condition. This man or his clerk should be required to keep a terminal sheet accounting for the entire period that the locomotives are at the terminal. This sheet should also show a record of the crews bringing in the engine and despatched with the engine. A suggested form is shown in one of the engravings; the columns "Arrival at terminal" and "Time leaving terminal with train" refer to the time the locomotive enters or leaves the switch from the road tracks to the main yard. The use of these columns would of course be optional, but they account for the time lost in the yard. This information, of course, must be telephoned to the enginehouse, if these columns are used. A glance at this sheet shows very quickly just how efficiently the terminal is being operated.

The storekeeper and his force form a department which can either make or break a terminal. How many times is an engine held for days awaiting some part, for example, a spring, which when received can be put in place within an hour and the engine made ready for service? The storekeeper should be preferably a mechanic and must be thoroughly familiar with his material and its use.

DISCIPLINE

In order to keep detentions arising from locomotive failures at a minimum and secure proper repairs, too much stress cannot be laid upon the proper disciplining of men. It should be remembered that inspectors are selected for their ability and that their value depends absolutely upon their judgment. Anyone is liable to err at times, but it is not best to impose discipline on inspectors, for they can always retaliate by "playing safe" and reporting numerous defects which in reality should not be reported, resulting in a great deal of work being "passed up" as unnecessary, with a certain amount very likely to be passed up that *is* necessary, once the habit is formed. On the other hand, if all items are repaired money and time will be wasted. If it is found that an inspector is continually failing, neglectful, or using faulty judgment, he should be removed rather than be continuously a subject for discipline. Insofar as the question of discipline generally is concerned, great care should be exercised by the foreman before imposing a penalty, for at best the enginehouse is no heaven to the man who must face its conditions day or night year after year.

The question of relief days has been found to have considerable influence on the amount of discipline imposed. When possible, a scheme should be in effect whereby each man will have at least one day off per week if he so desires. This does not necessarily mean that the man will be off on Sunday. In order to allow the force a regular relief day, it is of course necessary to provide a large number of extra men, this extra force being assigned for convenience to the gang leader of laborers. When a regular system of relief is applied there is a notable drop in the number of men absent due to sickness or with minor excuses.

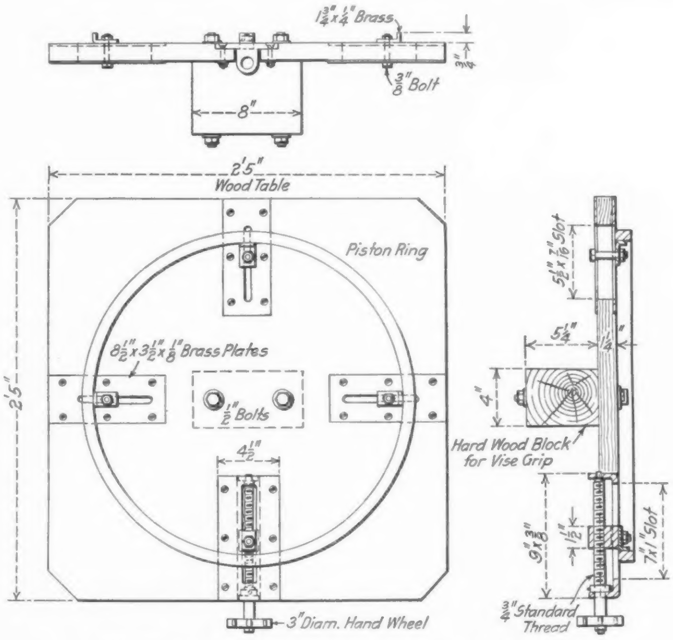
Considering the elimination of detentions, a system should be followed whereby every passenger locomotive detention and, if possible, every freight detention is thoroughly investigated and brought to a conclusion, the information being furnished the master mechanic in charge and the enginehouse foreman who despatched the engine. Locomotive failures usually occur in epidemics due to some part being neglected. To eliminate the detentions the cause must be located and a remedy applied. Every failure has a cause; some of the causes may not be very evident, but they exist, and careful analysis will usually show them; the remedy is usually self evident.

The writer has endeavored to confine himself to the fundamentals, for a book could be written if all the various details were to be discussed. In conclusion it might be said that the statements in the article are not theoretical as the operations upon which they are based are in every-day use in two large enginehouses whose cost per engine handled and detentions per engine-mile are very conservative.

VISE CHUCK FOR FILING PISTON RINGS

By R. J. HICKMAN

The device shown in the drawing has proved very convenient for use when filing packing rings to fit the grooves in the piston head. It consists of a wood table 2 ft. 5 in. square, to which are fitted four circular chuck jaws. The jaws are adjustable to accommodate rings from 16 in. to 26½ in. inside diameter, three of the jaws being permanently adjusted for each size of ring and the fourth provided with



Piston Ring Chuck for Use in the Bench Vise

an adjusting screw, by means of which the ring is clamped in place.

To the under side of the table is bolted a wooden block 5¼ in. deep, 4 in. wide and 8 in. long. This block is of hard wood and is gripped in the bench vise. With the ring in place and the chuck clamped in the vise, the edge of the ring is exposed for filing throughout its circumference.

A BROAD CONCEPTION OF APPRENTICESHIP*

By V. T. KROPIDLOWSKI
Chicago & Northwestern Shops, Winona, Minn.

A mature man should be put at the head of the apprentice department, one who is extremely liberal-minded, merciful and free from inclinations toward favoritism.

As to selecting new prospects and those for promotion, I do not believe in the highly-scientific doctrines of the psychologists, physiologists and craniologists; common-sense philosophy and good discretion are essential. A boy may have every sign of incorrigibility and the earmarks of a truant, yet if taken into confidence and intimate counsel, he may make the best man.

As to providing education, a good plan would be a combined system of understudies and correspondence courses. Every officer, clerk and trade should have understudies. The

*Entered in the competition on "How Can I Help the Apprentice?" which closed September 1, 1915.

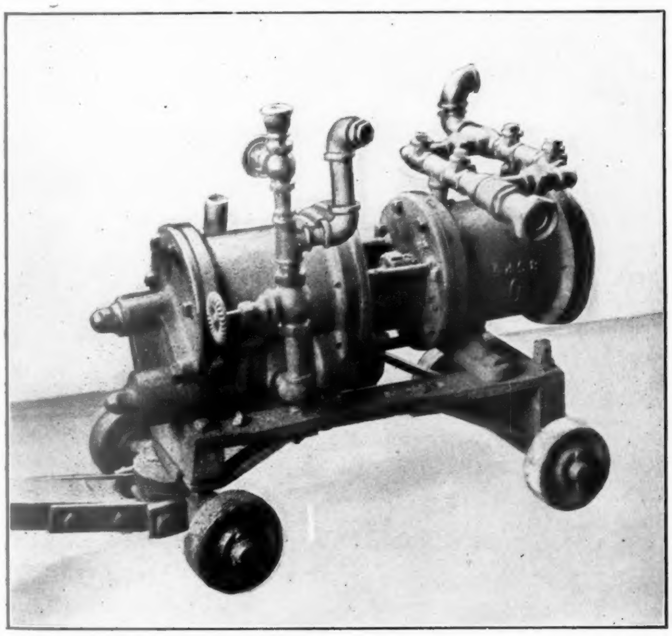
head of the bureau should see that *all* have understudies. The bureau should provide the curriculum for the correspondence courses and the understudy's immediate superior should act the teacher. For shop apprentices and other vocations, shop instructors may act as teachers. Additional instructions in shops should be carried on regularly each week along the line of studying materials and demonstrations in tools and machinery, etc.

Reports from immediate superiors should be required and followed up by representatives of the bureau to ascertain if true. Some idea of the progress students are making can be had from the correspondence courses, but natural characteristics can be learned only through personal intercourse, for which the bureau's representatives must make periodical searches. Individuals of exceptional ability should be picked and given special training. They should then be put through every phase of railroading until they reach their highest goal.

A system of apprenticeship ought to embrace all branches of railroading. Night study ought not be encouraged as a permanent thing. Railroads will benefit more through conserved vitality and good-will if instructions and studying can be done within the working day—ambitious individuals will resort to night work upon their own initiative.

PUMP FOR TESTING BOILERS

The portable pump, shown in the accompanying illustration, is used at the Danville roundhouse of the Chicago & Eastern Illinois for washing out locomotive boilers. It consists of an old New York air compressor, which is operated by air from the shop lines. Air is admitted to the steam end and water to the air end of the pump, as indicated in the illustration, the air cylinder being bushed to whatever diameter is desired to give the required pressure. The air



Boiler-Testing Pump

and water connections are clearly shown in the illustration, four check valves being provided to govern the proper distribution of the water between the ends of the cylinder. The outfit is mounted on a small four-wheeled truck for transportation to any part of the roundhouse.

VISCOSITY OF LUBRICANTS.—Viscosity tests, so called, do not necessarily prove anything of the lubricating quality of an oil, since rosin or other viscous oils may constitute a large proportion of the whole and yet have no lubricating value.—*Power.*

RULES FOR THE SAFE HANDLING OF PAINTS AND OILS

BY J. W. GIBBONS
General Foreman, Locomotive Painters, Atchison, Topeka & Santa Fe., Topeka, Kans.

The danger involved in the handling of paints and oils can generally be attributed to ignorance of their nature. It is of importance that everyone having to do with materials of this kind should know how to handle them without risk of accident or injury to health. How to handle them will be best understood from a general knowledge of the characteristics of the different kinds of oils used in paints and varnishes. These oils belong to two general classes—volatile oils and vegetable oils. The various kinds of paints and varnishes contain oils of either one or both of these classes, which differ considerably from each other in their characteristics.

VOLATILE OILS

Volatile oils are distillates from crude petroleum, coal tar, asphalt, grain, pine gum and wood products. The commonly used oils of this class are naphtha, gasoline, benzine, benzole, turpentine and alcohol. Coal oil, headlight oil and fuel oil are also of a more or less volatile nature and properly belong to this class.

There is no danger of spontaneous combustion from volatile oils, unless they are mixed with coal dust or other material which will generate heat. All volatile oils are, however, explosive, the danger from this source depending upon the degree of volatility. Care should be taken never to expose them to an open flame or a live spark, and in filling containers space should always be allowed for expansion and to make the proper allowance for this a knowledge of the highest temperature to which the oil will be subjected is necessary. These oils constantly throw off gas and in storing or transporting them the containers should be absolutely air tight. As a further precaution on large tanks a safety valve should be provided to release the accumulated gas should abnormal conditions of temperature arise. Should a leak occur in a container of volatile oil, repairs should never be attempted until the contents have been removed and the fumes thoroughly removed from the interior by filling the container with water or running air through it. Many men have been killed or injured in attempting to repair supposedly empty oil tanks or cans.

In using volatile oils for cleaning purposes, or varnish removers containing such materials, a bucket with a hinged lid should be used. A portable danger sign should also be placed where it may be seen by all who may come near. The containers should also be painted a distinctive color, red being preferred.

When a vessel containing volatile oils becomes ignited, no one should ever attempt to carry it from the building. More injuries occur and more large conflagrations are caused in this manner than by the explosion of the oil. In attempting to carry the container it is often upset, causing what would otherwise have been a small fire to spread rapidly to large proportions. All danger of explosion is past after the first flash, which is due to the ignition of the accumulated gas. When this gas is consumed the oil will burn evenly and if the flame does not endanger the surrounding property, the fire will often burn itself out with no other damage than the loss of the oil and possibly the container. If the container is equipped with a lid the fire may be readily extinguished by closing the lid, which smothers out the blaze. Fire extinguishers are also very effective in putting out oil fires. Water should never be used unless it can be thrown with sufficient force to completely smother the blaze. Otherwise, it will only result in spreading the fire. Sand may often be used effectively in controlling a fire of this kind.

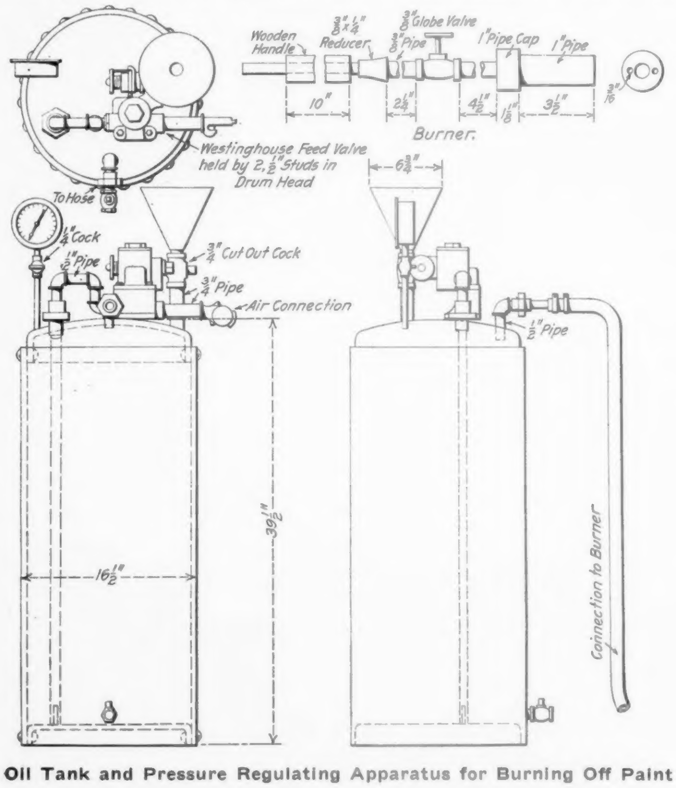
One of the most dangerous methods of using volatile oils

is in the hand torch commonly employed by painters, tinners and electricians. Great care should be exercised to see that torches of this kind are in good condition and properly filled and that too much air is not pumped into the torch. Years ago a man working for the writer was burned to death by the explosion of one of these torches and in order to eliminate this danger the paint burning equipment shown in the drawing was developed. The distinctive feature of this outfit is the use of a Westinghouse slide valve feed valve to regulate the pressure on the oil tank.

But the danger of explosion and fire are not the only ones to which the users of volatile oils are exposed. There are others which, because of their insidious nature, are seldom guarded against. The United States Bureau of Labor has issued Bulletin No. 120 dealing with this phase of the subject. This bulletin is entitled "Hygiene of the Painter's Trade" and from it the information which follows has been taken:

Turpentine causes headaches, dizziness, dry throat, bronchitis and irritation of the urinary system.

The fumes of gasoline, naphtha and benzine will poison the system. If this poisoning becomes chronic it results in



Oil Tank and Pressure Regulating Apparatus for Burning Off Paint

indigestion, bronchitis, loss of strength and even in impaired mentality.

The fumes of benzole, a large percentage of which is used in paint and varnish removers, may rapidly prove fatal. The symptoms are inflammation and ulceration of the gums and lips.

The fumes of amyl-acetate, which is used in varnish remover and in bronzing and guilding fluids, are narcotic, causing headaches, nausea, palpitation of the heart and difficult breathing.

Wood alcohol is sometimes used in cutting shellac and in paint and varnish removers. It is a dangerous poison, relative to the improper use of which the Committee on the Prevention of Blindness for the State of New York has the following to say: "As much blindness and death have been caused by breathing the fumes of wood alcohol as by swallowing the liquid."

Men using varnish and paint removers should be furnished with respirators and rubber gloves.

VEGETABLE OILS

Among the vegetable oils generally used in mixing and grinding paint are linseed, cotton seed, soy bean, China wood, sunflower and corn oils. These oils are not explosive except at very high temperature, but they are all more or less subject to spontaneous combustion, due to the heat generated by the oxidation of the oils. This danger is greatly increased when litharge, manganese or other oxidizing agencies are used with the oil. Linseed oil, the quickest drying vegetable oil, is more dangerous in this respect than the others.. When used in cleaning or polishing, the rags or waste with which the oil is applied should always be gathered up and burned.

Most paints contain either vegetable or mineral oil, while some contain both. Varnish is made up of vegetable oils and gums reduced with naphtha. Paints and varnishes are therefore either explosive or subject to spontaneous combustion. It is evident that they should be stored in a clean room as fireproof as conditions will permit, and whether in storage or in transit if a leakage is discovered, prompt steps should be taken to avoid the danger of fire or explosion. It is not alone through leakage that dangers may arise, but frequently the barrels or containers which have been set aside as empty, contain enough oil to start a fire or cause an explosion. Care should be taken to see that all residue is removed before empty barrels are stored or cans are sent to the shop for repairs.

The danger from the handling of lead and Paris green pigments are not great with the modern methods of painting railway equipment, as they are but seldom used. In sandpapering, however, men so employed either should be protected with respirators or should work in a well-ventilated room.

The precautions necessary to the protection of health and property in handling paints and oils may be summed up in the following list of "Don'ts":

Don't use varnish remover or volatile oil in an ill-ventilated room unless you are properly protected from the fumes.

Don't use them anywhere unless you have a danger sign.

Don't smoke or carry an open light in a room where they are used or stored.

Don't keep open a can or bucket of volatile material when not in use.

Don't use wood alcohol for any purpose when a substitute, such as denatured alcohol, can be secured.

Don't leave waste or rags containing oil or grease in the shop over night.

Don't store your dinner bucket in a room where paints or oils are stored.

Don't fail to wash before eating.

Don't eat in an ill-ventilated room containing paints or oils.

SPECIAL LUBRICANTS FOR LIGHT MACHINERY.—Special mixtures of oil are necessary in some cases, but for light machinery using only small quantities, a mixture of 80 per cent light mineral and 20 per cent sperm is good and should not cost more than 30c. per gallon. It will not, however, stand heavy bearing pressure or form a film at slow speed. Its film thickness on metal is about 0.0002 in.—*Power.*

TEST FOR LUBRICANTS.—A simple experiment in order to find out if a lubricant contains corroding substances is to cover a steel surface with the lubricant and expose it to the sunlight for about two or three weeks. If the lubricant contains acid the steel surface will show etchings, while water will oxidize the steel and the surface will show rust pits. This experiment should be made with a highly polished surface and a roughly ground surface as the effect of the acid shows up best on a polished surface, while the rusting can be observed better on a rough surface.—*Graphite.*

Chesapeake & Ohio Scrap Reclamation

Savings Effected at the Huntington, W. Va., Shops; Special Buildings and Machinery Are Employed

BY H. M. BROWN
Shop Superintendent, Chesapeake & Ohio, Huntington, W. Va.

During the past three or four years no one item has received greater care or attention on the Chesapeake & Ohio than the reclamation of scrap, the officers realizing that a vast amount of slightly worn material requiring but a small expenditure to put again in service, finds its way to the scrap bins. The saving effected by reclamation has caused this class of work to be more appreciated.

Special tools and equipment have been installed, some of which we have manufactured ourselves, designed to accomplish as economically as possible the various operations necessary to put the materials in practically new condition. However, the cost of reclamation is not carried to such an extreme that it would have been best to consign the material to the scrap dealer and purchase new stock, for I believe that in a great many instances the work of reclamation can be overdone.

Equipment for Reclaiming Nuts

The buildings that are termed "scrap shops" are made from scrap, all of the lumber used being that removed from cars undergoing repairs and the covering being old car roofing. The buildings are kept nicely painted and a fairly successful attempt has been made to keep them and their surroundings in a neat and orderly condition. The moral effect in an operation of this kind must necessarily be felt in the results that are obtained as a whole.

We handle at our Huntington shops practically all the scrap from the entire system. As these shops are located in the center of the system, it is a convenient point for handling work of this nature, and while we do not have what might be termed a central scrap dock operated under a separate and distinct organization, we have, on the other hand, been working along lines which it is believed are best suited to our conditions and will result in the greatest economy. Other shops along the line have become interested and instead of the railway company being burdened with the expense of having a separate organization, we find interest manifested at each terminal in seeing that nothing is wasted that could be used to good advantage. In this way considerable additional expense is saved on the reclamation of various articles by eliminating the labor of handling at the terminals. The freight from the various terminals to the central shop, the unloading and handling after arrival and the final reshipment must all be considered, and I believe these items are overlooked in a great many instances when calculating the final cost.

When the cars of scrap arrive at Huntington, they are unloaded on a special platform into wagons where the scrap is sorted by gangs under the supervision of a foreman who is capable of passing on it. All the larger and heavier material is handled by two yard cranes, one of which is equipped with a magnet. After the scrap is sorted, that which is to be sold is loaded directly into cars which are consigned to the scrap dealers, thereby saving an additional handling which would be involved if we were to place the scrap in bins and then later transfer it from the bins to the scrap cars.

We watch the various items reclaimed to see that we are not overdoing the work and putting back into service material that will possibly fail and cause trouble, in which case the labor of application would be lost. To guard against this the articles reclaimed are carefully inspected.

Rolling Mill at the Huntington Shops

BOLTS AND NUTS

All scrap bolts are sent to the blacksmith shop where the ends are sheared off if bad and the bolts rethreaded. There

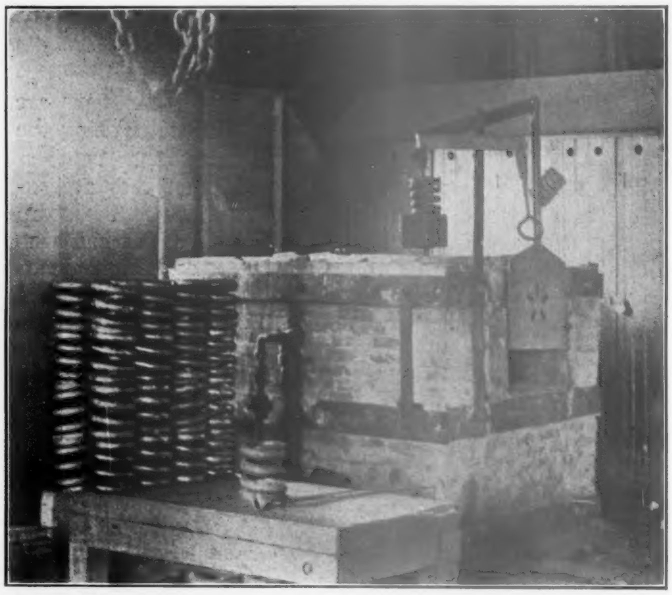
is provided a single and double head bolt machine that does practically nothing else but this class of work. The bolts are then boxed by sizes and are ready for reapplication. We reclaim on an average of 200,000 bolts per month.

The scrap nuts are collected, annealed and rattled, and are then sent to the sorting room in which is located a long table to enable them to be sorted quickly and placed in bins. There are located in the same building two seven-spindle nut-tapping machines which are in close proximity to the bins, so that the nuts after being sorted can be easily and quickly handled to the tapping machines, and from the machines into kegs ready for use. All of this work is handled on a piece-work basis. We reclaim 125 kegs of nuts per month.

There is also located in this building a large alligator shear which is used to shear up rods into bolt lengths if the iron is in good condition. These bolts are then sent to the blacksmith shop, headed and threaded. This shear is also used to cut heavy wrought iron bars into lengths suitable for the furnaces at the rolling mill.

ROLLING MILL

All iron that cannot be used in its present shape (for example, old arch bars are used for step brackets for switching engines, the filling pieces removed from composite bolsters



Furnace for Reclaiming Coil Springs

are used for re-enforcing steel center sills) or which would not be too expensive to forge to size to enter the rolls, is sent to the rolling mill. This is in a separate building, constructed from scrap material. There is a large furnace and a motor-driven set of Ajax reclaiming rolls. There are rolled approximately 1,000 tons per year, and at present prices of iron and steel, quite a saving is effected. Average saving, after deducting cost of scrap, labor, maintenance, fuel and supervision, amounts to $1,100 per month.

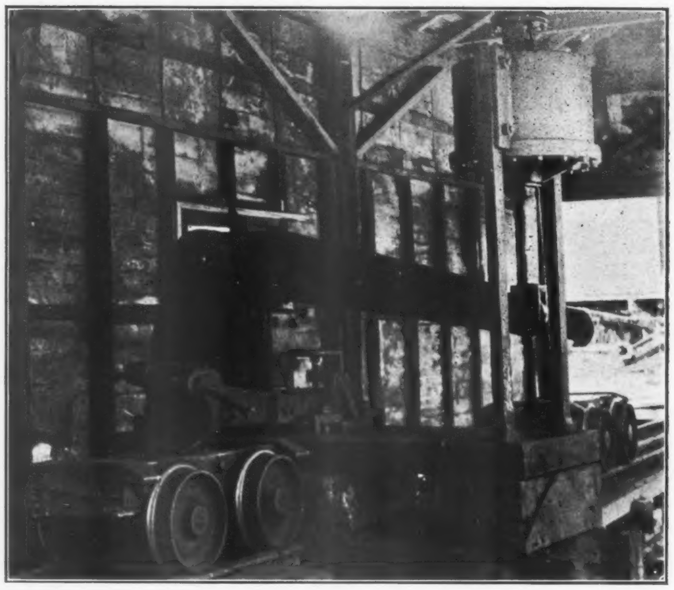
SPRINGS AND COUPLERS

Located in the rolling mill building is a coil spring reclaiming plant, the furnace being constructed from scrap arch brick and firebrick broken in transit. The springs are sorted, heated and the coils separated to give proper height; they are then tempered and tested and are again ready for service. From 100 to 125 springs are reclaimed per day.

Steel couplers with the stems bent, eyes pulled out, guard arms bent or otherwise damaged are sorted and sent to a specially constructed shed, where the yokes are stripped from them by a special machine, shown in one of the illustrations. The couplers are then sent to the blacksmith shop where they are electrically welded, if necessary, or straightened as the case may be, and returned to service. There were 4,800 heads saved thus during 1915.

BLACKSMITH SHOP

No one department has afforded a better opportunity to effect a reclamation than the blacksmith shop, and parts that are bent or broken can be straightened or welded at a nominal cost. Track tools of all kinds, such as adzes, spike mauls, long bars and claw bars are straightened, redressed



Machine for Removing Coupler Yokes

and if need be new ends upset or the ends rewelded. Machinists' hammers are manufactured from scrap knuckle pins, as well as solid end wrenches up to 1½ in. (nut size) from scrap spring steel for the use of the machinists and carmen. Other work carried out here is the flattening of old tubes and the punching of split keys and washers; the using of scrap pieces of steel sheared from plates in the manufacture of car and locomotive work to make knuckle pin washers, gusset plates, etc.; the use as patches for the side and floor

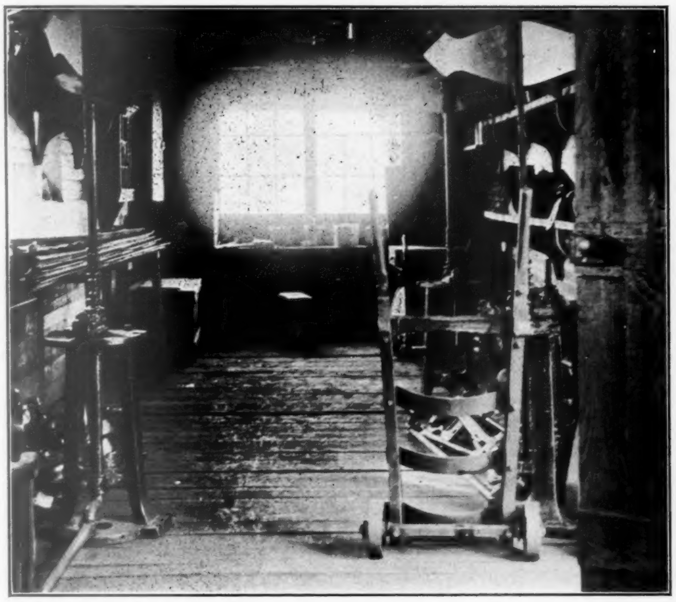
Straightening a Drawbar

sheets of steel cars of old sheets removed from steel cars that have certain portions good for further use. This has not only increased the output but has reduced the cost of car maintenance. The saving effected by making repairs in this manner, instead of applying new side and floor sheets, amounts to approximately $4,000 per month. Old locomotive tires are used for the manufacture of guides, and on account of the

excessive cost of tool steel for dies, we are now using dies in the bolt and rivet forging machines that are manufactured from tire steel. These dies are giving excellent results.

MAINTENANCE OF WAY MATERIAL

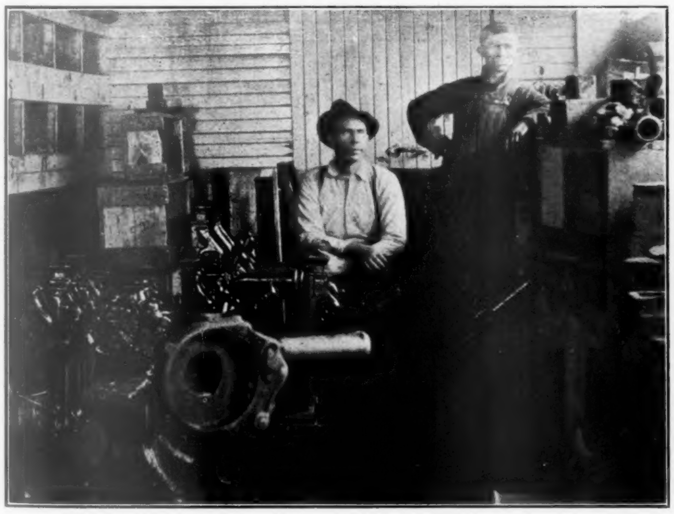
Parts of switch stands, cuffs from switch points, and rods are sorted and re-assembled. We have a separate building for this work where all work of this nature is handled. All the stands are carefully inspected and worn out or broken parts,



Switch Stand Repair Shop

if they cannot be repaired by the electric welder or in the blacksmith shop, are renewed. Stands and rods when complete are shipped wherever needed on the system. Broken frogs are repaired, parts being furnished by the manufacturers. We do not have a frog or switch shop to handle this work.

All hand and motor cars, as well as baggage wagons, track drills, jacks, levels and station skids are repaired, either removing and replacing the parts damaged or taking two or



Shop for Repairing and Reclaiming Car and Track Jacks

three of the same articles and making one good article from the undamaged parts. Approximately $2,000 per month is saved in this manner.

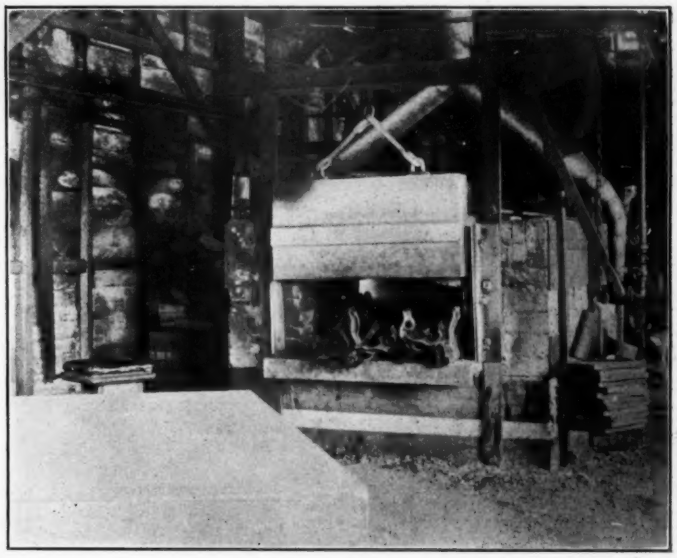
We have a special shop for the handling of all jacks and we reclaim approximately from 50 to 60 jacks per month and effect a saving of from $200 to $250.

BRAKEBEAMS

On account of accessibility, and at the same time to overcome the danger from flying rivets, the brakebeam shop is segregated from the other buildings and is especially constructed to handle this particular phase of the work. The beams are stripped of broken or bent parts, using a special rivet buster for the work of cutting off the rivets, and the beam, if bent, is then passed into the furnace where it is heated, and removed from the opposite side to a surface plate, where it is straightened. It is then passed to the assembling bench where new parts are applied. The truss rods for these beams are rerolled scrap and the nuts those which have been retapped. We have reclaimed over 1,900 beams in one month with a saving of over $1.00 per beam, the labor cost being 15 cents per beam. We have not found it necessary to get a single new brakebeam from the storeroom in the past two years, enough being saved by reclamation to care for the cars repaired that require brakebeam renewal. This is quite an item when it is considered that we repaired 41,209 light, heavy and rebuilt cars in 1914.

BRASS FOUNDRY SCRAP

No one item of scrap receives closer attention than the brass. In the case of every broken fitting that has brass parts, the brass portion is removed, as well as all copper wire that cannot be used for joints on glands, etc. All of the old



Furnace and Surface Plate for Straightening Brakebeams

electric wire has the insulation removed and the copper melted. Old lead plates from storage batteries are melted, impurities removed, and the lead cast into ingots, using the proper proportion of other metals to meet specifications. This is used for lining car bearings and crossheads and for any purpose requiring a good bearing metal. The brass is stored in bins and the bronze is carefully housed.

AIR BRAKE APPLIANCES

In the building for the reclamation of jacks is also located equipment for repairing and mounting air hose. Fittings are stripped from the old hose on a home-made machine, cleaned and reapplied. Over 90 per cent of the fittings are returned to service. The air hose that have a certain portion good are used to make dummy hose connections, but one of the best savings effected is the use of the old air hose as a holder for the cutters used in the steel car yard. The expense of manufacturing cutters with an eye in the head, and supplying wooden handles, when the use and abuse that these tools receive is considered, makes the cost of maintenance excessive; but by making a 1¾-in. chisel 10 in. long and driv-

ing it through an old air hose, a satisfactory cutter is obtained. In addition to the amount saved in eliminating handle breakages and in the manufacture of the cutters there is no danger of injuries due to the missing of the cutter and striking the handle. All steam hose are stripped and remounted in this department, all of this work being handled on a piece-work basis. In another section air brake cylinders and reservoirs are reclaimed, as well as retaining valves that find their way to the scrap bins. Parts that are broken are removed and the good parts are collected and reassembled.

The angle cock grinding machine is located in another building. Twelve cylinders can be ground simultaneously with this machine. We are able to make repairs to all angle cocks that are sent in for repairs or those that arrive with the scrap.

Triple valves are cared for in the pipe and copper shop where we have a complete test rack, and the valves after being repaired undergo a very rigid test. The same method is pursued in this department as in the others, that of discarding broken pieces and saving the good parts in order to build up a complete article.

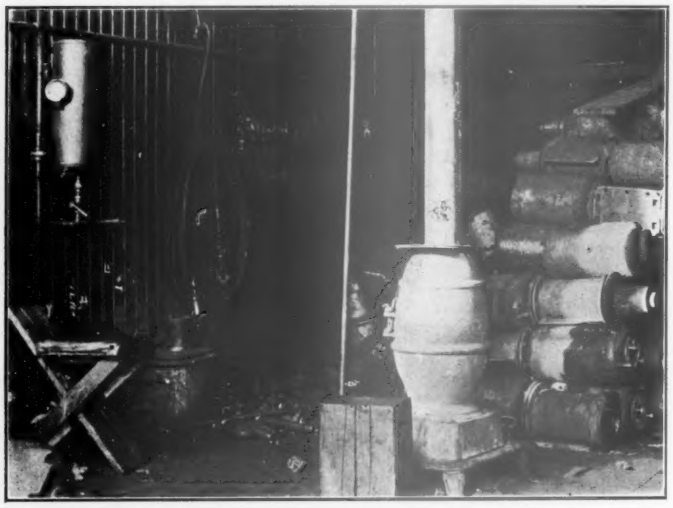
LAGGING, ETC.

Old boiler lagging that is removed is sent to a building where it is ground up and remoulded. Quite a saving is effected in this manner at a nominal cost.

Scrap car roofing plays an important part in the scrap yard, the buildings being constructed of it. Wash buckets are manufactured for the shops as well as for the locomotives; also wash basins for caboose cars, fire buckets, swab casings for piston rods and valve stems, stove pipe, oil cans, gutters for shop buildings, etc.

A large number of switch and hand lanterns are reclaimed each month, as well as gage lamps, classification and marker lamps, by simply boiling in a vat, renewing the broken parts and applying the necessary lenses.

Globe valves that are scrapped on account of the seat being badly cut, stem bent, handle broken off or lost, are easily re-



Reclaimed Air Brake Cylinders

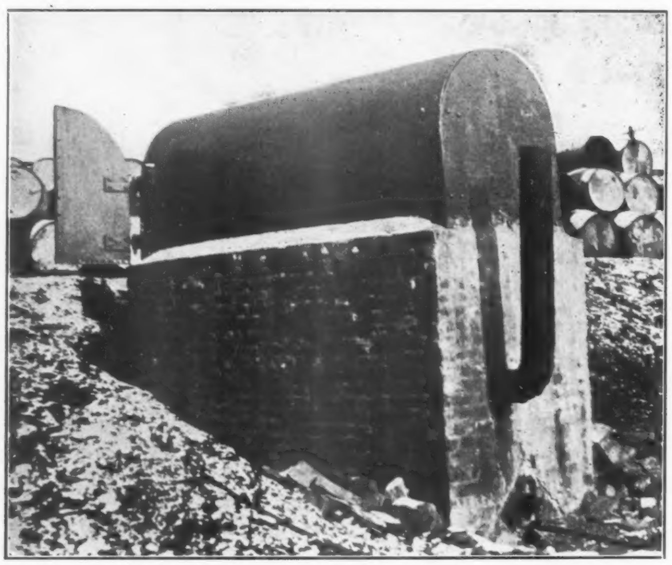
claimed and returned to service by the renewal of the broken or worn out parts. We reclaim approximately 200 of these valves per month at a saving of about $150.

After the old passenger car roofing is removed on account of being worn out it is placed over a furnace and all of the solder is removed, remelted into sticks and sent to the tin shop for future use. It is also surprising the amount of copper that is thus reclaimed and sent to the brass foundry. Old dope is gathered up, carefully cleaned and reapplied. Old pipe is used for sand pipes on locomotives, as well as cut up and used as thimbles for various requirements.

Reflex water gage glasses are reground on a machine constructed in the shop, at a cost of three cents each. Bullseye lubricator glasses are reground on an Aloxite wheel and repolished and returned to service at a cost of one cent each.

All of our oil is received in metal drums and as a consequence a considerable amount of heavy bodied oil sticks to the side of the drums, especially so in cold weather. The drums are heated and the oil collected and used about the shops for the lubrication of machinery.

Car wheels that are slid flat and removed, and which would otherwise be scrapped, are placed in a grinding machine and



Furnace for Melting Heavy Oil from Sides of Metal Barrels

the flat spots, if not too deep, are ground out and the wheels returned to service. On account of the accuracy of the grinding it gives practically ten per cent more wear than a wheel that is bored and mounted in the usual manner. The saving thus effected amounts to approximately $600 per month.

Old carpets removed from dining and parlor cars are cut up into suitable sizes and with a plate and handle made of old car roofing, used as a dust collector in front of the journal boxes on passenger cars.

There is a great wear on the corners of coach seats, and after transferring the backs from one side to another and both corners become worn it would be necessary in order to avoid this unsightly appearance, to apply a new roll on the top of the back. To overcome this feature we save the good portions of plush removed from repairs to seats and backs and make a cap to cover the corner, thus saving the labor of transferring the seat backs or applying new plush rolls. On a first-class coach the cost of labor and material to renew the rolls on the backs would amount to about $142, while caps can be applied at a cost of from $14.00 to $18.00.

Old paint is saved to make a compound for use on pipe joints. Varnish residue is drained and applied to joints and used in other places where a gum is required.

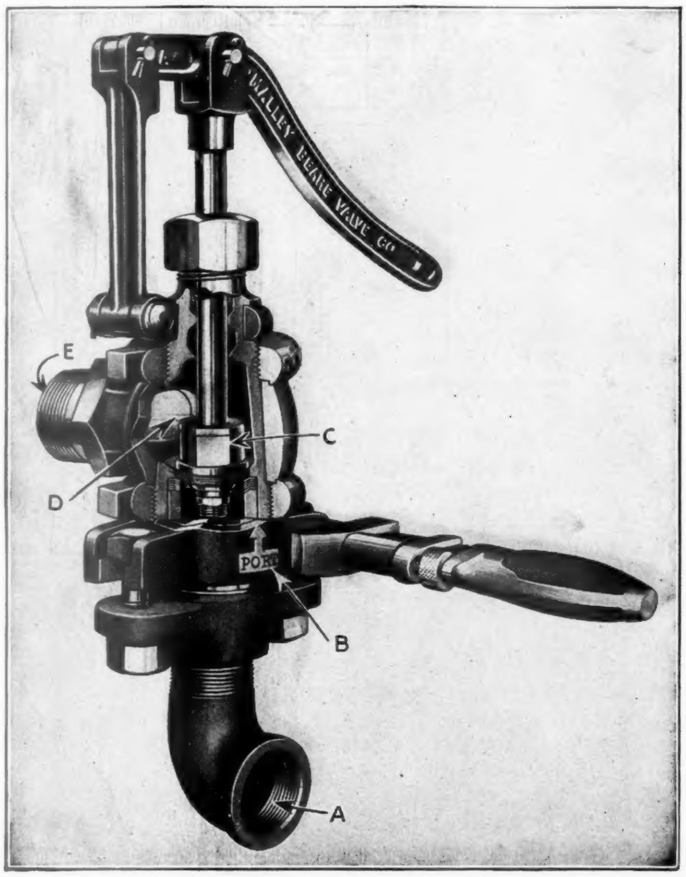
High Speed Drills.—A fact often lost sight of, even by experienced users of drills, is that cutting ability and hardness are not the same thing. This is especially true of high-speed drills, the apparent hardness of which varies with the composition of the steel, and is no indication of cutting ability. Some of the best high-speed tools ever tested could be filed so readily that if this were any indication of the work to be expected of them they would be condemned without a working trial. A high-speed drill that cannot be filed may, by exercising the greatest care, be made to drill extremely hard material successfully; but for softer materials it will be found so brittle as to be worthless.—*The Engineer.*

NEW DEVICES

MULTIPLATE VALVES

In the development of a general policy of fuel economy, that wasted because of leaky valves should be given consideration as well as that lost in other ways. Steam valves of various types are often allowed to remain in a leaky condition with a resultant fuel waste because of lack of time to regrind them, or from the lack of proper facilities.

The O'Malley-Beare Valve Company, Chicago, realizing the need of a valve that can easily and quickly be made steam-tight by even an inexperienced workman, has developed the Multiplate valve. Its general construction is substantially the same as that ordinarily used, with the exception that the valve head and the valve seat are made up of several uniform superimposed metal plates held in place with suitable retaining nuts. As the valve wears and begins to leak, the bonnet is removed and a plate from both the seat and the head is discarded from the magazine of plates in the valve. The bonnet is then replaced, the valve being in the same condition as when new. As the plates are used they may be replaced by new ones. In case there are none at hand the valves can be used without them, the master seats in the valves being properly machined for this purpose. The thickness of the plates represents the amount of metal that is ground off the heads and seats of valves of other types when it is necessary to repair them for leakage.

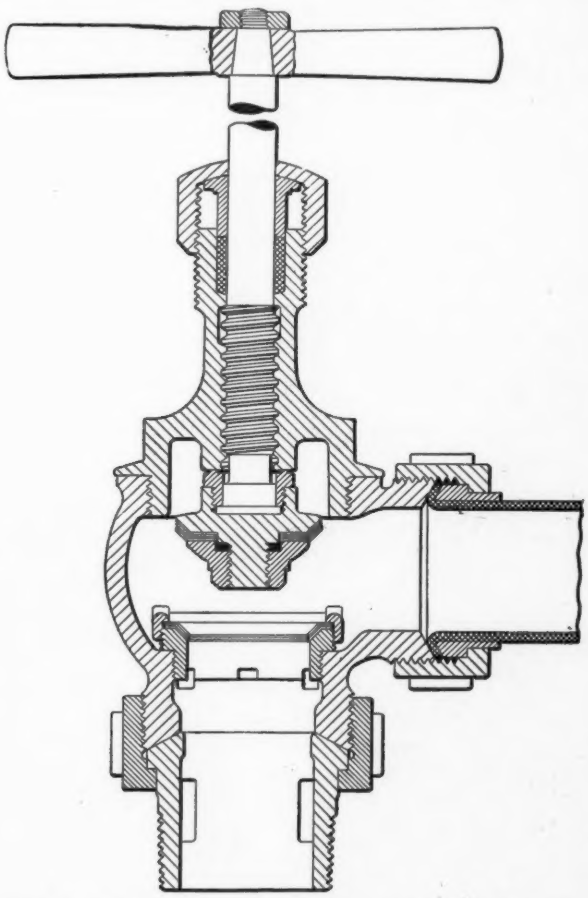


O'Malley-Beare Multiplate Blow-Off Valve

A—Outlet; B—Arrow Indicating Port Position; C—Service Valve; D—Port; E—Pressure Inlet. The monkey wrench is shown in position for cutting the valve out of service.

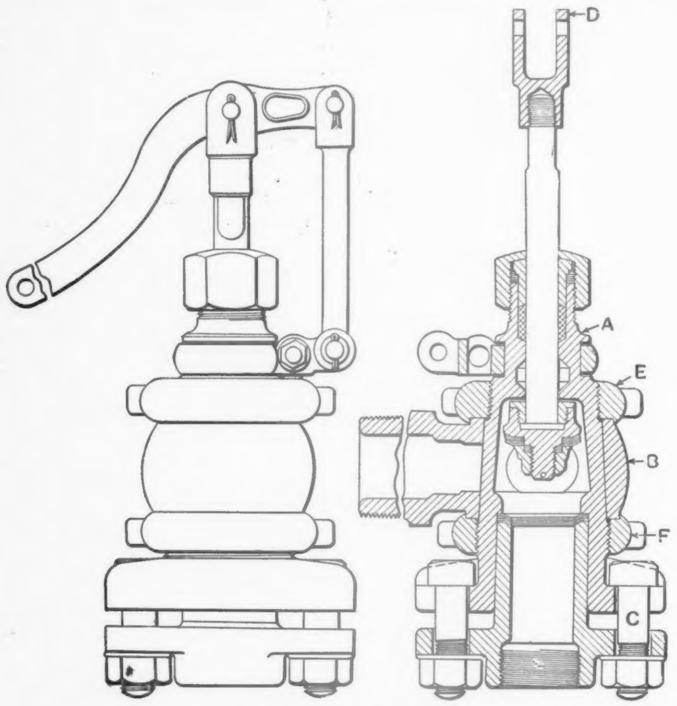
An interesting feature of these valves is that the parts are interchangeable with valves of other makes; that is, the bonnet of the O'Malley-Beare valve can be applied to the body of numerous other makes. Multiplate valves of all types for all classes of service are made by this company. The composition of the plates used in the seat and head varies for the service in which the valve is used. Brass plates are provided for saturated steam valves, composition nickel and Monel plates are provided for superheated steam valves, and a plate of special mixture is provided for the thinner gases, such as oxygen and acetylene. The plates generally used are bevel in form, but in check valves, and in other valves where suitable, flat plates are used.

In addition to the medium and extra heavy valves, this company makes a Duplex Multiplate blow-off valve that is especially adapted to locomotive service. It is so constructed that the valve seat and the valve head can be removed for repairs with the boiler under pressure. The construction of this valve is shown in the illustrations. The valve body *A* has a steam tight taper fit in the outer casing *B*. An opening in the valve body when placed in line with the boiler connection cuts in the valve. By turning the valve body around 90 deg. the valve is cut out and at this time the valve seat and head can be removed. The valve seat is removed by releasing the seat bolts *C*, and the valve head is removed by removing the handle of the valve and the clevis *D*, and pushing the valve stem down through the valve. Notations are



Two-Inch Injector Fountain Stop Valve Showing the Seat Plates and the Nut Securing Them

cast in the outer casing and in the exposed part of the valve casing to show the position of the port in the valve body with respect to the boiler connection. The valve body is held in the outer casing by the adjusting ring *E* and the lock ring *F*. If after long service the valve body should stick in the casing

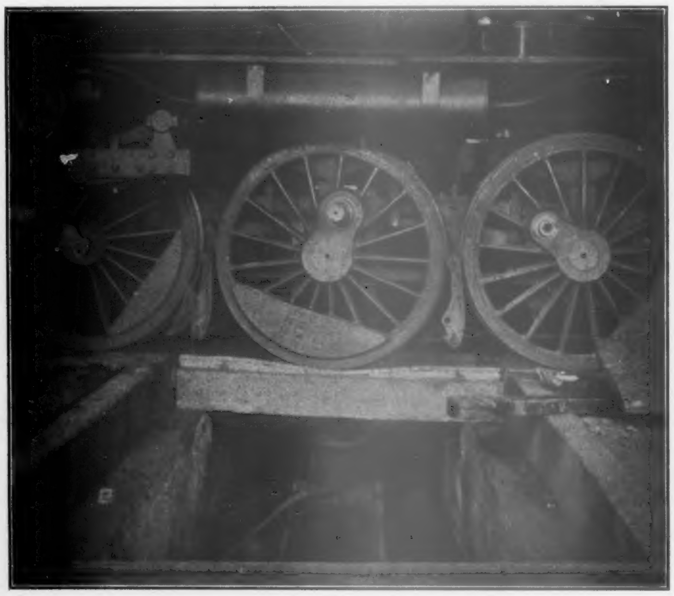


Multiplate Blow-Off Valve

when it is desired to cut out the valve, it can be relieved by a slight adjustment of these nuts. The same general principle is followed in the application of the valve plates in this valve as in the other types of valves.

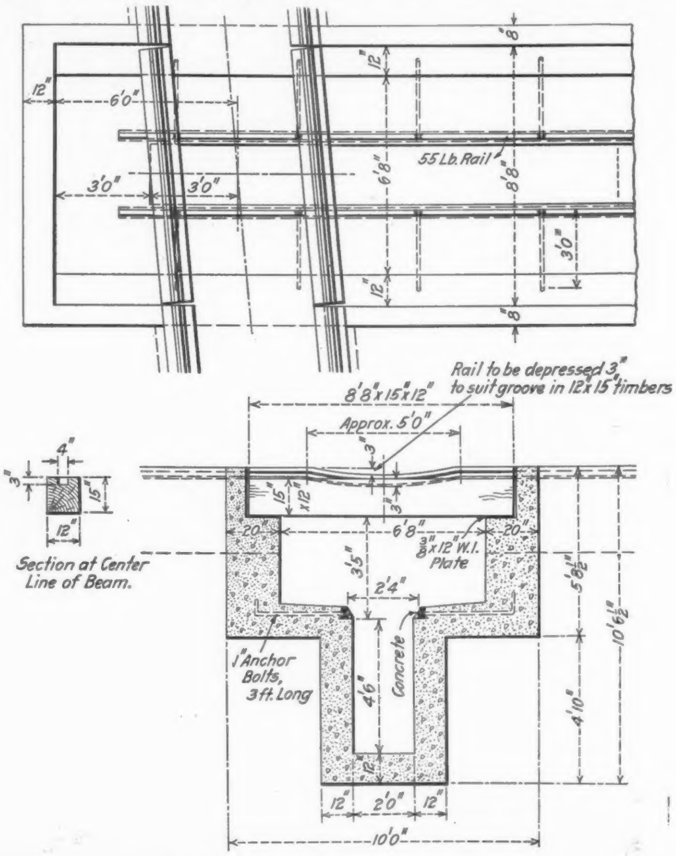
IMPROVED DROP PIT

In removing driving wheels from a locomotive by means of a drop pit the ordinary practice is to place the engine so



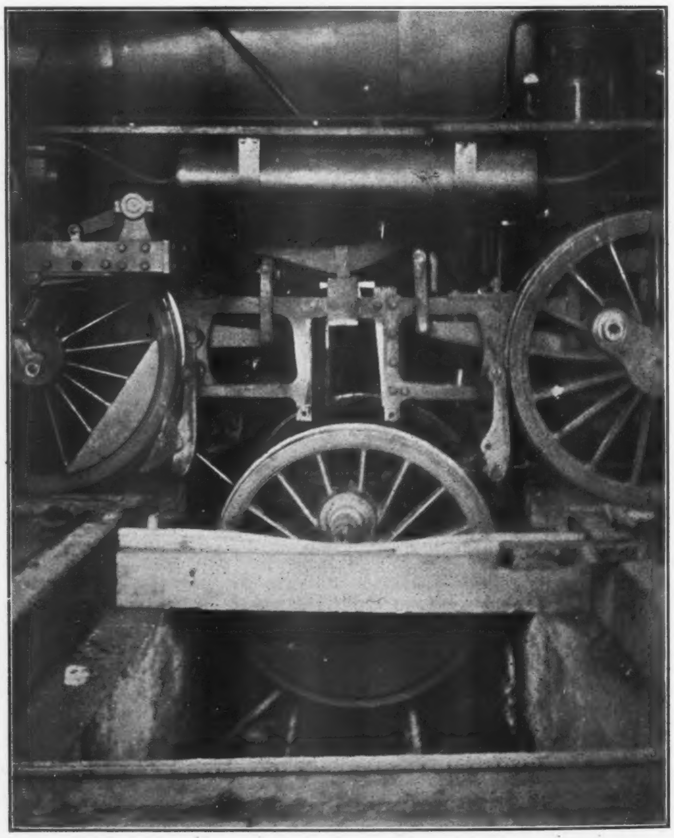
Locomotive in Position Ready for Removal of Wheels

that the wheels which are to be removed are over the pit and then raise the locomotive by means of jacks. In order to obviate the necessity of jacking up the locomotive, a method of removing the wheels by blocking over the driving boxes to take the weight off the axle, has been devised by



General Arrangement of the Drop Pit

W. J. Pamplin and S. C. Morton, Waycross, Ga. In using this drop pit, which is shown in the illustrations, blocks are



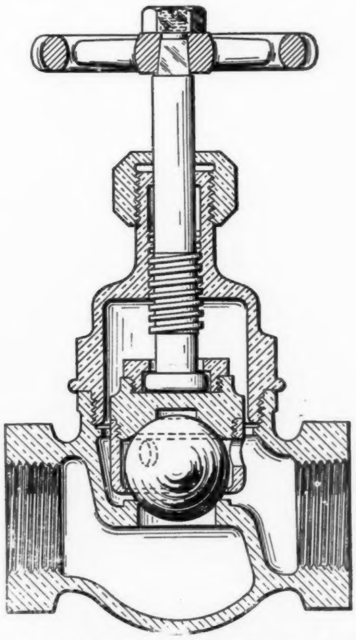
Drop Pit in Use Lowering a Pair of Driving Wheels

placed over the driving boxes of the wheels which are to be removed and the engine is then run over the pit, this pair of driving wheels being lowered by means of a depression in the pit rail. The weight is thus relieved from the axle and the ordinary form of drop pit jack is run up and raises the wheels enough so that the pit rails may be removed. The jack is then lowered and the wheels transferred to the next adjoining track and raised to the floor level as in the ordinary form of drop pit.

This design of drop pit has been patented by the inventors. In one case where it is in use on the Atlantic Coast Line, the main driving wheels were removed from a locomotive, the brasses rebored and refitted and the wheels replaced, the entire work from the time the engine was placed over the pit until it was again ready for service being accomplished by a machinist and two helpers in six and one-half hours.

DETROIT BALL VALVE

The accompanying illustration shows the ball valve made by the Detroit Valve Company, Detroit, Mich. The interesting feature of this valve is, as the name implies, the ball disc. This ball, which is made of a hard bell metal, is held suspended in a case, being free to rotate in any direction. The valve seat is of a socket form, being rounded to an angle of 45 deg. In closing the valve the ball is lowered onto its seat, but it is not ground in as is the case with a flat valve disc on a flat seated valve. Further turning of the valve



Globe Valve Closing with Spherical Joint

stem presses the ball tightly into its seat, while the cupped cage holder slightly rotates around the ball. It makes, in fact, a ball and socket joint. In opening, the ball valve case releases its grip on the ball, lifting it off the seat without any grinding effect on either the ball disc or the seat. As the valve is opened the ball will be rotated slightly, thus giving a constantly changing surface each time the valve is operated. This same plan is adopted for globe, angle and check valves, the parts being interchangeable for each size of valve.

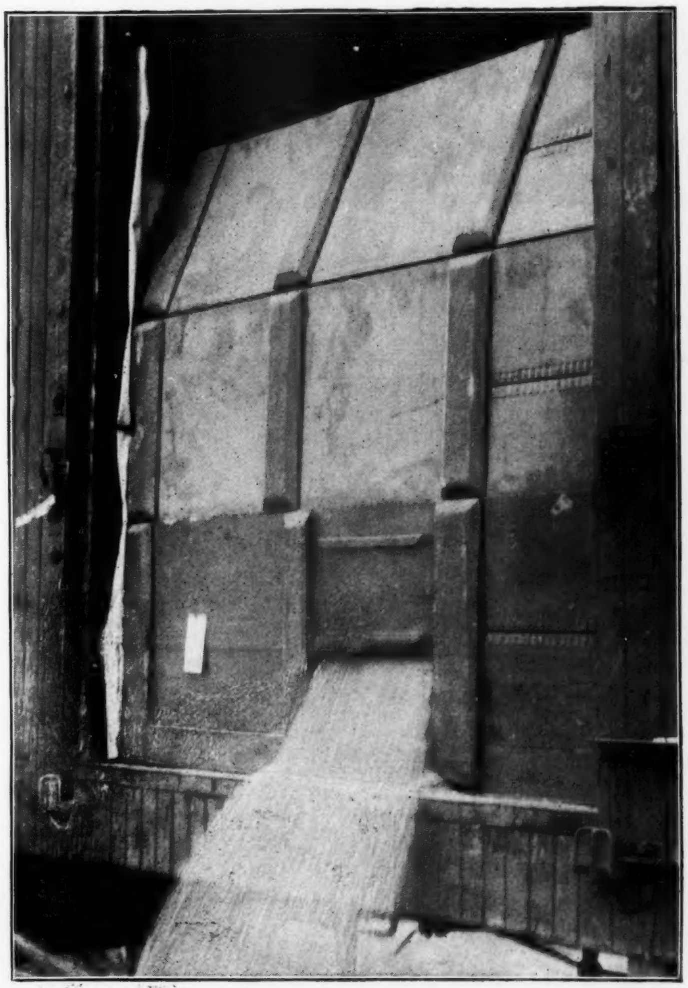
The Duntley Products Sales Company, Fisher building, Chicago, Ill., has been granted exclusive railway sales rights for this valve.

Weight of Oil.—The lightest oil used for lubrication has a specific gravity of about 0.865 and the heaviest about 0.930. The commercial range is from 0.885 to 0.907.—*Power.*

UNIVERSAL GRAIN DOOR

An efficient and practical grain door which has been in use on 50,000 cars in this country, and is the standard on some roads, has been placed on the market by the Universal Grain Door Company, Transportation building, Chicago. This door was formerly known as the McNulty nailless grain door; no nails whatever are required in its application to a car. With it a car can be coopered for a shipment of grain in five minutes and the door can be removed under load in less than two minutes. In either its application or removal it is unnecessary to mutilate either the door posts of the car or the grain door itself. The fact that no nails are required in its application is a decided advantage, for where these nails are used the door post soon becomes badly mutilated. One of the illustrations shows such a post and the damaging effect of such conditions to other freight is apparent, especially to shipments of flour in bags. One road attempted to remove all nails in the door post before offering the cars to shippers of such commodities, but this was found to be an expensive practice.

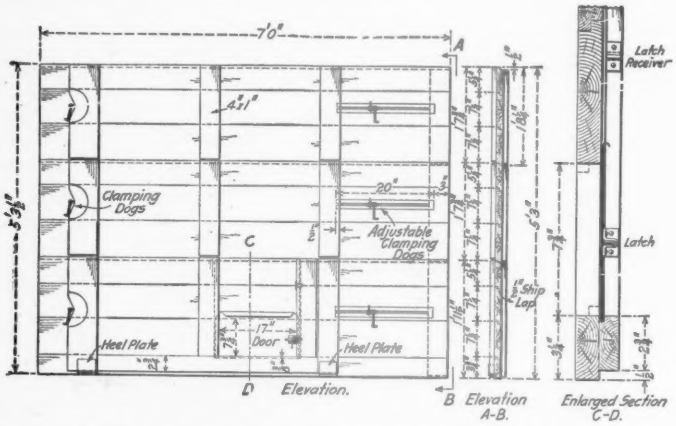
The ease with which this door may be removed is an important factor from the standpoint of the amount of grain handled at the elevators. With the ordinary nailed door it takes from 10 to 20 minutes to clear the doorway so that the shovelers may enter the car. By reducing this time to less than two minutes the number of cars handled at an elevator may be increased from 20 to 25 per cent, which is an important item to both the railroads and the elevator operators, as more grain can be handled per day and the cars will be more promptly released when they are needed most. This door is handled in the same manner as the ordinary grain



Universal Grain Door

door, that is, it is not a permanent part of the car. When removed from a car the doors may be used in any other car or shipped back to the grain fields for further use. It is a permanent door temporarily used.

The construction of the door is quite simple. It is made in three parts, similar to the ordinary nailed door, preferably of 1⅝ in. dressed ship-lapped lumber. A relief door of sheet metal is provided in the lower section. This door slides



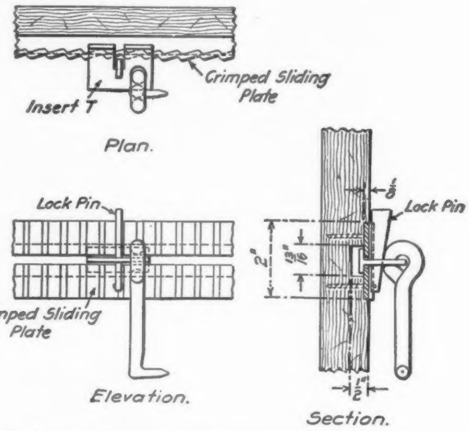
Details Showing Location of the Clamping Dogs

in metal guides and provides an opening 17 in. by 7¾ in. It is held opened or closed by a small latch. The doors are held firmly to the door posts by clamping dogs driven into the sides of the door posts, two to each door. They have sufficient rake to pull the door tight to the posts as they are driven in. A fixed dog is applied at one end of the door and an adjustable dog at the other, in order to provide for the varying widths of car door openings. The adjustable dog is keyed to a crimped sliding piece fixed in the door, as

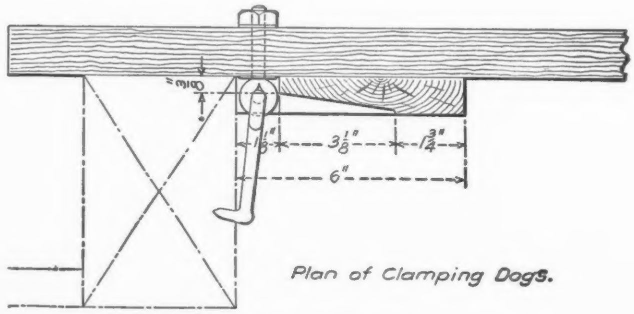
Door Post Damaged by Use of an Ordinary Type Grain Door

indicated in the illustrations. Provision has been made for the use of bars when removing the doors, two heel plates being provided at the lower end of two of the battens in the lower door.

It is claimed that these doors will pay for themselves in from two to four trips, in that they may be used several times with practically no repairs, and that they can be applied and removed in a very short time. The labor and material required in their application are much less than with the ordinary type of nailed door in that no nails are required,



Details of Adjustable Clamping Dogs.

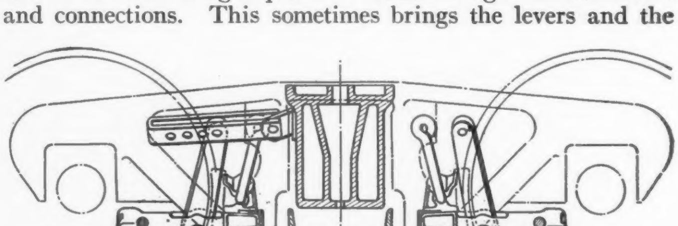


Details of the Clamping Dogs

and there is no occasion to destroy the doors in unloading the cars. These doors can be applied grain tight, and some roads that are using them report that the claims for grain losses have been reduced by their use.

AJAX THIRD POINT SUPPORT

There is a tendency for the forward end of a brake beam to tilt downward when the brakes are in the release position, due to its own weight plus the added weight of the levers and connections. This sometimes brings the levers and the



Ajax Third Point Support

end of the brake beams low enough to strike crossing planks and obstructions between the rails which is liable to tear off the rigging and cause derailments. It also causes the upper part of the brake shoes to drag on the wheels, producing uneven brake shoe wear and some retarding effect to the train. Furthermore, with the brake beam in this position an application of the brakes brings the brake beam to its acting position with a jerk, causing irregular stresses on the beam.

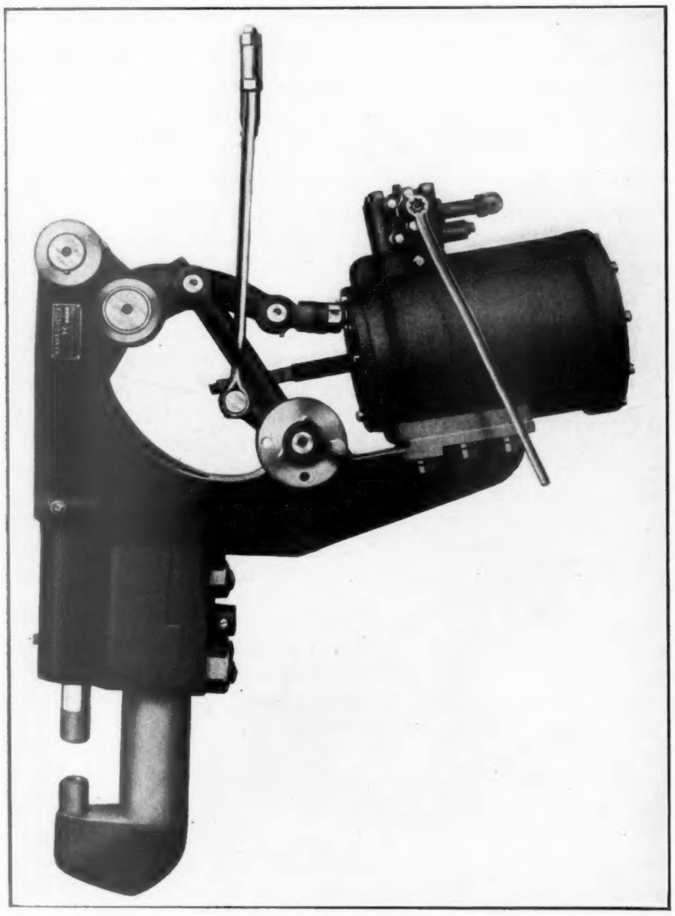
To overcome these undesirable features the American Steel

Foundries, Chicago, has brought out the Ajax third point support for brake beams. It consists of a link hung from the end of the brake beam and supporting the end of the bottom brake rod. It is simple in construction and in addition to keeping the brake beam in proper alinement it serves as a safety device in that the bottom brake rod connection will be held in place should the pin connecting it with the brake lever become lost.

PNEUMATIC DOOR RING RIVETER

The type of pneumatic riveter shown in the illustration has been developed especially for driving boiler door ring rivets. The main frame is a steel casting to which are secured the cylinder, the stake and the operating mechanism. It is designed for swinging suspension and the arrangement is simple and compact.

This machine is built by the Vulcan Engineering Sales Company, Chicago, and employs the Hanna operating mechanism. This provides a gradually increasing pressure



Hanna Door Ring Riveter

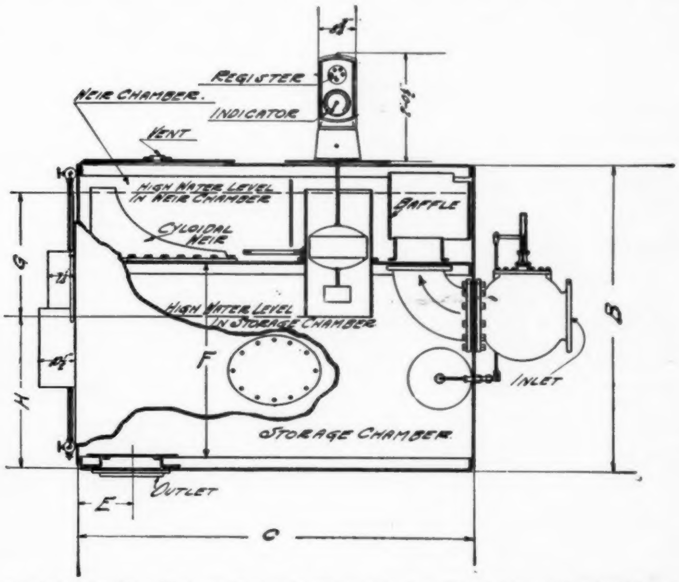
through the greater part of the stroke until the desired maximum is reached, after which the pressure remains uniform until the completion of the stroke. The toggle mechanism, the plunger and the piston head are steel castings. High carbon steel is used for the piston rod, die screw, lower die holder and dies.

Liquid for Hydraulic Jacks.—A hydraulic jack should be filled with alcohol 1 part, water 2 parts, with a tablespoonful of sperm oil added. It should never be filled with water, kerosene or wood alcohol. Water is liable to freeze or rust the jack; kerosene destroys the packing; wood alcohol destroys packing and corrodes the metal.—*Engineering and Mining Journal.*

CYCLOIDAL WEIR METER

A water meter of the weir type has recently been developed by the Kennicott Company, Chicago Heights, Ill., in which the rate of flow varies directly as the head of water in the weir chamber. The arrangement of the device is shown in the drawing. Other forms of weirs in common use are objectionable when applied to recording meters because of the complicated recording apparatus required, the rate of flow in every case being a more or less complicated function of the head. With the cycloidal weir the direct proportion of the rate of flow to the head makes possible the use of the simplest form of recording mechanism and accuracy may be obtained without difficulty.

The weir itself is a simple box casting, the upper surface of which is cycloidal in contour. It is open at the bottom and is bolted or riveted over a slot in the bottom of the weir



Cycloidal Weir Meter; Rate of Flow Varies Directly with the Head

chamber. Throughout the length of the cycloidal surface is a slot accurately machined to a uniform width through which the water flows from the weir chamber to the storage chamber in the lower part of the meter. With this device it will be readily seen that as the height of the water increases, thus increasing the rate of flow though the lower part of the weir, the relative length of the weir slot exposed gradually decreases, thus compensating for the effect of the increased head over the lower portion of the weir. Patents have been secured covering the form of the weir.

Autogenous Welding in Boiler Repairs.—Autogenous welding for effecting boiler repairs is convenient in many instances, but its advantages are apt to lead to oversight of the real causes which produce the defects the welding is intended to remedy.—*The Engineer.*

Blowing Out Stationary Boiler Tubes.—The frequency with which the blower should be used depends on the type of boiler, the soot-producing qualities of the fuel, the efficiency of firing, and on whether a hand blower or a mechanical blower is used. If the blower is of the mechanical kind that is fixed permanently in place and that blows all the tubes at one time, the labor required to operate it is reduced, and blowing may be done two or three times in a day of 24 hours. But if the hand-operated, single-jet blower is used, the labor involved reduces the number of cleanings to one a day. It seems to be generally conceded that the tubes should be blown at least once a day. But if much soot is formed it will be found economical to blow them out oftener, even at the expense of additional labor.—*Electrical World.*

Railway Mechanical Engineer

(Formerly the RAILWAY AGE GAZETTE, MECHANICAL EDITION *with which the* AMERICAN ENGINEER *was incorporated)*

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WE GUARANTEE, that of this issue 7,800 copies were printed; that of these 7,800 copies, 6,790 were mailed to regular paid subscribers, 95 were provided for counter and news companies' sales, 357 were mailed to advertisers, exchanges and correspondents, and 558 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 23,400, an average of 7,800 copies a month.

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VOLUME 90 MARCH, 1916 NUMBER 3

CONTENTS

NEWS DEPARTMENT

According to a press report the Canadian Pacific has decided to use only Canadian hardwoods for interior finish of sleeping, parlor, dining and observation cars as well as offices and hotel buildings.

The Southern Pacific has announced that at the end of the fiscal year it will award a watch fob, with a gold charm, to each of the six men on each division and in each general shop who rank highest in the number of points scored for safety suggestions.

The Baltimore & Ohio's Safety First campaign during the past year has produced gratifying results. Employees have held 204 safety committee meetings, and have made 17,066 recommendations in the interest of safety; and 16,411, or 96 per cent, of these were disposed of. To the general use of goggles by mechanics, the company's physician attributes a prevention of fifteen injuries to employees' eyes on one division. There has been a decrease in the number of accidents, though the force was augmented to handle increased business, and inexperienced men were taken into the service.

The management of the Atchison, Topeka & Santa Fe has selected four recent graduates in woodworking from among the apprentices in the Topeka shops, and has arranged for them a special course of six months in the shops of the Pullman Company, where arrangements have been made to give the apprentices every opportunity possible to familiarize themselves with the Pullman Company's method of constructing cars. Some time ago the Santa Fe selected seven of its brightest machinist apprentice graduates for a similar special course at the plant of the Baldwin Locomotive Works.

The Pennsylvania Railroad reports that its fire losses on the whole system last year amounted to only eight cents on each $100 of property at risk. The total fire loss for the year was $278,730, which was paid out of the road's own insurance fund. The value of the property exposed to fire hazard, and insured by the fund, is about $350,000,000. Employees extinguished 441 fires, buildings, yards, etc., before the arrival of public fire companies. Organized fire brigades among the employees put out 84 of these fires, and locomotives equipped with fire fighting apparatus were used in putting out 40 fires. High pressure fire lines built by the railroad were used in six fires. Spontaneous combustion caused 15 fires, 36 started on adjacent property, and 12 were of incendiary origin. Lightning caused 2, boys 2, and tramps 11, while 130 were of unknown origin. Carelessness with tobacco and matches caused 12 fires which destroyed $10,091 worth of property.

CARS AND LOCOMOTIVES ORDERED IN FEBRUARY

The orders for freight and passenger cars reported during the month of February did not come up to the high level set in the last three months of 1915, nor were they as large in amount as those reported during January. The orders for locomotives, on the other hand, were unusually large, the total for the month being greater than that for any month during the last two years. The totals were as follows:

	Locomotives	Freight cars	Passenger cars
Domestic	534	12,988	75
Foreign	479	3,200	..
Total	1,013	16,188	75

The New York Central will receive a large proportion of all the locomotives ordered during the month, it having contracted with the Lima Locomotive Corporation for 70 Mikado and 25 eight-wheel switching locomotives, and with the American Locomotive Company for 29 Mountain type, 25 eight-wheel switching and three Mallet type locomotives. It has also authorized certain of its own shops to proceed with the construction of about 150 locomotives, a total of 302 locomotives. It is also understood, further, that the company contemplates purchasing 100 more locomotives from outside builders. Other important domestic and foreign orders were as follows:

Road	No.	Type	Builder
Baltimore & Ohio	50	Mikado	Baldwin
	10	Mogul	Lima
Bessemer & Lake Erie	20	Santa Fe	Baldwin
Illinois Central	20	Pacific	American
Lehigh Valley	20	Mikado	Baldwin
Southern Pacific	20	Pacific	American
Cuba Railroad	25	Ten-wheel	American
English Government	20	....	Baldwin
French Government	80	Pechot	Baldwin
Russian Government	350	Gasolene	American

The last named order is for 7-ton narrow gage locomotives.

Among the important freight car orders were the following:

Bessemer & Lake Erie	750	Gondola	Pressed Steel
	750	Gondola	Standard Steel
	500	Gondola	Amer. Car & Fdy. Co.
	500	Gondola	Ralston
Lackawanna Steel Company	700	Hopper	Amer. Car & Fdy. Co.
	700	Hopper	Standard Steel
Southern Pacific	900	Box	Ralston
	760	Stock	Ralston
	650	Flat	Ralston
	275	Flat Bodies	Ralston
	1000	Box	Haskell & Barker
	250	Gondola	Haskell & Barker
	3	Caboose	Mt. Vernon
	601	Automobile	Ralston
	303	Tank	Amer. Car & Fdy. Co.
Cuba Railroad	350	Flat	Amer. Car & Fdy. Co.
	350	Box	Amer. Car & Fdy. Co.
	500	Cane	Amer. Car & Fdy. Co.

The important passenger car orders included the following: International & Great Northern, 5 coaches, 2 dining and 2 postal cars, American Car & Foundry Company, and the Southern Pacific, 10 baggage, 20 combination baggage and mail, 2 combination passenger and baggage cars, and 18 coaches, Pullman Company.

EXHIBITS AT THE JUNE MECHANICAL CONVENTIONS

The exhibit committee of the Railway Supply Manufacturers' Association held a meeting at the office of the association in the Oliver building, Pittsburgh, on February 18, for the purpose of assigning space for exhibits, making arrangements for hotels, furniture, decorations, etc.

About 70,000 square feet of space was assigned. Announcement was made that the association has also received a large number of inquiries concerning space, many of which will doubtless result in formal applications. Too much emphasis cannot be given to the request that those desiring exhibit space file their applications immediately as the remaining space is rapidly being taken. The committee expects to issue circulars shortly concerning the arrangements for hotels, furniture, decorations, etc.

MEETINGS AND CONVENTIONS

Central Railway Club.—The annual meeting and dinner of the Central Railway Club will be held at the Hotel Statler, Buffalo, N. Y., on March 9, 1916. The business session will be held in the afternoon at two o'clock, followed by a reception and dinner at seven o'clock in the evening.

Air Brake Association.—The twenty-third annual convention of the Air Brake Association will be held May 2-5, 1916, at the Hotel Ansley, Atlanta, Ga. The following subjects will be considered at the convention: Slack action in long passenger trains, its relation to triple valves of different types, and consequent results in the handling of passenger trains; proper piping of locomotives and cars, specifications and requirements for pipe in air brake work; adequate hand brakes in heavy passenger equipment cars; best method of educating apprentices to give the railroad companies efficient air brake mechanics; care of modern passenger brake equipment and factors contributing to the minimum cost of maintenance with the maximum efficiency; accumulation of moisture and its elimination from trains and yard testing plants; need of efficient cleaning and repairing of freight brakes, and recommended practice.

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations:

AIR BRAKE ASSOCIATION.—F. M. Nellis, 53 State St., Boston, Mass. Convention, May 2-5, 1916, Atlanta, Ga.

AMERICAN RAILROAD MASTER TINNERS', COPPERSMITHS' AND PIPEFITTERS' ASSOCIATION.—W. E. Jones, C. & N. W., 3814 Fulton St., Chicago.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.—J. W. Taylor, Karpen Building, Chicago. Convention, June 19, 1916, Atlantic City, N. J.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—Owen D. Kinsey, Illinois Central, Chicago. Convention, July, 1916.

AMERICAN SOCIETY FOR TESTING MATERIALS.—Prof. E. Marburg, University of Pennsylvania, Philadelphia, Pa. Convention, June 27-July 1, Traymore Hotel, Atlantic City, N. J.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Calvin W. Rice, 29 W. Thirty-ninth St., New York.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—Aaron Kline, 841 Lawlor Ave., Chicago. Second Monday in month, except July and August, Hotel La Salle, Chicago.

CHIEF INTERCHANGE CAR INSPECTORS' AND CAR FOREMEN'S ASSOCIATION.—W. R. McMunn, New York Central, Albany, N. Y.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—J. G. Crawford, 547 W. Jackson Blvd., Chicago. Convention, May 15-18, Hotel Sherman, Chicago.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—William Hall, 1126 W. Broadway, Winona, Minn. Convention, August 29-31, 1916, Hotel Sherman, Chicago.

INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION.—A. L. Woodworth, Lima, Ohio. Convention, August, 1916, Chicago.

MASTER BOILER MAKERS' ASSOCIATION.—Harry D. Vought, 95 Liberty St., New York. Convention, May 23-26, 1916, Hollenden Hotel, Cleveland, Ohio.

MASTER CAR BUILDERS' ASSOCIATION.—J. W. Taylor, Karpen Building, Chicago. Convention, June 14, 1916, Atlantic City, N. J.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION OF U. S. AND CANADA.—A. P. Dane, B. & M., Reading, Mass. Convention, September 12-14, 1916, Wilmington, Del.

NIAGARA FRONTIER CAR MEN'S ASSOCIATION.—E. Frankenberger, 623 Brisbane Building, Buffalo, N. Y. Meetings monthly.

RAILWAY STOREKEEPERS' ASSOCIATION.—J. P. Murphy, Box C, Collinwood, Ohio. Convention, May, 1916.

TRAVELING ENGINEERS' ASSOCIATION.—W. O. Thompson, N. Y. C. R. R., Cleveland, Ohio. Convention, September, 1916, Chicago.

RAILROAD CLUB MEETINGS

Club	Next Meeting	Title of Paper	Author	Secretary	Address
Canadian	Mar. 14	Heat Treatment of Steel	G. W. Pressell	James Powell	St. Lambert, Que.
Central	Mar. 9	Interchange Rules. Discussion	Committee	Harry D. Vought	95 Liberty St., New York
New England	Mar. 14	Annual Meeting, Election of Officers	....	Wm. Cade, Jr.	683 Atlantic Ave., Boston, Mass.
New York	Mar. 17	Annual Electrical Night	....	Harry D. Vought	95 Liberty St., New York
Pittsburgh	Mar. 25	Interchange Rules; Repairs to Foreign Cars	E. S. Way	J. B. Anderson	207 Penn Station, Pittsburgh, Pa.
Richmond	Mar. 13	Train Handling by Air	Robert Burgess	F. O. Robinson	C. & O. Ry., Richmond, Va.
St. Louis	Mar. 10	The Railroad Eight-Hour Movement	W. L. Park	B. W. Frauenthal	Union Station, St. Louis, Mo.
South'n & S'w'rn.	Mar. 16	Nature's Invisible Forces	T. H. Ellis	A. J. Merrill	Box 1205, Atlanta, Ga.
Western	Mar. 21	....	....	Jos. W. Taylor	1112 Karpen Bldg., Chicago

PERSONAL

GENERAL

CHARLES A. BINGAMAN, assistant engineer of motive power of the Philadelphia & Reading, at Reading, Pa., has been appointed mechanical engineer of the Philadelphia & Reading and subsidiary companies. The position of assistant engineer of motive power has been abolished.

PHILIP H. CONNIFF has been appointed assistant superintendent of motive power and machinery of the Florida East Coast, with headquarters at St. Augustine, Fla.

F. G. LISTER has been appointed mechanical engineer of the El Paso & Southwestern, with office at El Paso, Tex. Mr. Lister previously served on the Spokane, Portland & Seattle and affiliated lines at Portland, Ore.

T. D. SEDWICK, chief chemist of the Chicago, Rock Island & Pacific, has been appointed acting engineer of tests in place of F. O. Bunnell, resigned.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

A. C. ADAMS has been appointed master mechanic of the Virginia division of the Seaboard Air Line, at Raleigh, N. C., succeeding G. H. Langton.

B. P. JOHNSON has been appointed master mechanic of the Seattle division of the Northern Pacific, with headquarters at Seattle, Wash., succeeding C. S. Larrison, deceased.

E. J. HARRIS has been appointed master mechanic of the Missouri division of the Chicago, Rock Island & Pacific, succeeding P. Linthicum, acting master mechanic, transferred.

G. F. SMITH has been appointed master mechanic of the Colorado, Kansas & Oklahoma, at Scott City, Kans.

MINOT R. SMITH has been appointed master mechanic of the Wyoming division of the Lehigh Valley, with headquarters at Coxton, Pa. Mr. Smith was born at Erie, Pa., November 5, 1870. He received his education in the public schools of Huntington, W. Va., and in Marshall College, located in that place. He entered railroad service as a machinist apprentice on the Chesapeake & Ohio at Huntington, in 1887, where he served in that capacity and as a machinist until 1899. He was then made machine shop foreman on the same railroad at Covington, Ky., in which capacity he served until his appointment as general foreman at Russell, Ky., in 1904. In 1910 he left the C. & O. to become machine shop foreman for the Louisville & Nashville at New Decatur, Ala., and later in the same year was appointed division master mechanic and shop superintendent of the Monon at Lafayette, Ind. Here he remained until his recent appointment with the Lehigh Valley.

B. P. JOHNSON has been appointed master mechanic of the Northern Pacific at Seattle, Wash., succeeding C. S. Larrison, deceased. Mr. Johnson was born October 1, 1869, at Mt. Holly, N. J., and received a common school education in Camden, N. J. Prior to entering railroad service Mr. Johnson served as a machinist apprentice in a jobbing shop in Philadelphia, Pa. His first railway service was with the Northern Pacific at Glendive, Mont., where he began work as a section hand in December, 1888. After serving in this capacity and as a car oiler for about a month he was transferred to the roundhouse where he served successively as caller, hostler's helper and boiler washer until 1890 when he became a locomotive fireman. He received his promotion as engineer in August, 1898, and served in that capacity until September, 1903, when he was appointed road foreman of engines. In April, 1908, he was appointed master mechanic at Glendive, which position he occupied until transferred to Seattle.

SHOP AND ENGINE HOUSE

G. H. LANGTON, master mechanic of the Seaboard Air Line at Raleigh, N. C., has been appointed shop superintendent of the Portsmouth, Va., shops, succeeding L. D. Freeman, who has been granted leave of absence on account of ill health.

PURCHASING AND STOREKEEPING

G. W. CONWAY has been appointed general storekeeper of the Louisville & Nashville, with office at Louisville, Ky., succeding S. G. Conner, deceased.

EDWIN MEYERS has been appointed assistant general storekeeper of the Louisville & Nashville, with headquarters at Louisville, Ky.

E. W. MYERS has been appointed storekeeper of the Duluth, Winnipeg & Pacific at Virginia, Minn., succeeding F. S. Mattey, resigned.

RUSSELL L. UNDERWOOD has been appointed storekeeper of the Cincinnati Northern, with office at Van Wert, Ohio, succeeding F. P. Clark, resigned to engage in private business.

OBITUARY

FREDERICK W. BUSSE, chief clerk to the general superintendent of motive power of the Baltimore & Ohio at Baltimore, Md., died in that city on February 24, at the age of 56 years. Mr. Busse had occupied that position since May 1, 1903.

SMITH G. CONNER, formerly general storekeeper of the Louisville & Nashville, died recently after a very short illness at his home in Louisville, Ky.

GEORGE A. HANCOCK, formerly general superintendent of motive power of the St. Louis & San Francisco, died suddenly on February 8, at Los Angeles, Cal., where he resided during the winter of each year. He retired from the service of the Frisco in 1912.

HARVEY L. LEWIS, formerly foreman of the car shops of the New York, Ontario & Western at Norwich, N. Y., died in that city on January 26, at the age of 41.

A. SHIELDS, who was master mechanic of the Canadian Northern at Winnipeg, Man., previous to 1912, died on January 18, in Rochester, Minn., at the age of 48.

CALVIN G. TURNER, until 1913 master mechanic of the Philadelphia, Baltimore & Washington at Wilmington, Del., died on January 25, at his home in Wilmington at the age of 64.

NEW SHOPS

VANDALIA.—This company is constructing an enginehouse layout which comprises a small four-stall roundhouse, a sandhouse, oil house and ash pit, at Bickness, Ind. This will cost about $20,000.

PENNSYLVANIA RAILROAD.—According to a newspaper report, the Pennsylvania is planning improvements to the Altoona, Pa., car shops, the most important of which is the installing of two new ovens for drying paint on passenger cars.

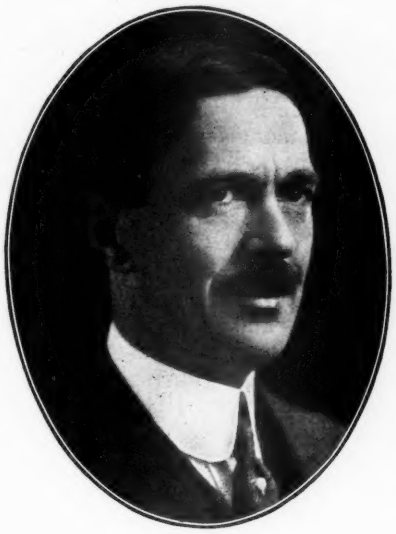
SOUTHERN RAILWAY.—This company will provide a special shop for repairs to steel cars at the Coster shops near Knoxville, Tenn. The new facilities will consist of an all-steel main shed 73 ft. by 480 ft., through which will extend three tracks, and a workshop 51 ft. by 100 ft., both to be equipped with overhead power cranes and a full complement of machinery and tools for repairing steel cars.

ATCHISON, TOPEKA & SANTA FE.—Final plans and specifications are being prepared for a new blacksmith shop at Albuquerque, N. M. It will be a steel-frame, brick structure with metal sash windows, 30 ft. long by 80 ft. wide, to cost approximately $60,000.

SUPPLY TRADE NOTES

A. B. Wegener has been appointed general manager of sales of the Camel Company, with headquarters at Chicago, Ill.

Herbert W. Wolff has been appointed vice-president of the American Car & Foundry Company, in charge of sales, with office at Chicago. Mr. Wolff was born on December 27, 1873, and was educated in the public schools of Detroit, Mich. He began his business career as an employee of the Michigan Car Company at Detroit in 1886. When the Michigan and Peninsular car companies were merged in 1892 under the name of the Michigan Peninsular Car Company, he remained in the service of the consolidated corporation. He was assistant mechanical engineer of this company in 1899, when the American Car & Foundry Company was formed, and went to St. Louis, Mo., to become chief mechanical engineer of the new company. In 1912 he was appointed assistant to the vice-president, with headquarters at St. Louis, which position he held until his recent promotion to the vice-presidency.



H. W. Wolff

P. M. Elliott, general manager of the Camel Company of Chicago, Ill., was recently elected vice-president of that company.

F. V. McGinness has been appointed manager of the railway department of the Edison Storage Battery Company. Mr. McGinness is a graduate of Columbia University, having received the degree of electrical engineer in 1910. After graduation he was, for a short time, with the New York & New Jersey Telephone Company and also with the New York & Queens Electric Light & Power Company at Long Island City, N. Y. In the latter connection he was occupied chiefly with computing distribution systems although at this time he received some practical battery experience. He became connected with the Edison forces in 1911, being then engaged in experimental work in Mr. Edison's laboratory. At this time he also received a through training in the manufacture of the Edison battery. Mr. McGinness has been engaged in railway storage battery work for the past four years. Previous to his appointment as manager of the railway department he was assistant manager of this department.

F. V. McGinness

Franklin Alter, president of the American Tool Works Company, Cincinnati, Ohio, died at his home in that city on February 27, aged 85 years.

The Q & C Company announces that it has discontinued its representation of the Ross-Schofield system of circulation of water in locomotive boilers.

F. O. Bunnell, engineer of tests of the Chicago, Rock Island & Pacific, has resigned, to become chief engineer of the Southern Wheel Company, St. Louis.

William H. Woodin, assistant to the president of the American Car & Foundry Company, has been elected president of that company, succeeding Frederick H. Eaton. Mr. Woodin received a technical education at Columbia University School of Mines. He worked his way through the shops of the Jackson & Woodin Manufacturing Company, Berwick, Pa., which company had been established by his grandfather in 1842, and was one of the companies amalgamated with the American Car & Foundry Company at the time of that company's organization. In 1892 he had become general superintendent of the Jackson & Woodin Manufacturing Company, and continued as such until 1895. From 1895 to 1899 he was vice-president, and in 1899 when the American Car & Foundry Company was formed, became district manager of the Berwick plant, the largest car building plant in the country. Since 1902 Mr. Woodin has been a director and assistant to president of the American Car & Foundry Company.

W. H. Woodin

A. W. Wheatley, vice-president and general manager of the Canadian Locomotive Company, Ltd., Kingston, Ont., has been elected president of the Lima Locomotive Corporation, at Lima, Ohio. Mr. Wheatley was born at Ashford, Kent county, England, October 12, 1870. At the age of 15 he became a rivet boy in the shops of the South Eastern Railroad, and in 1887 apprenticed himself as a machinist, attending the night school conducted by the railroad. In 1892 he came to America, finding employment on the Northern Pacific at Brainerd, Minn., as a machinist. In 1893 he was transferred to Staples, Minn., in the same position. In 1895 he was made foreman, occupying that position until 1900. He was transferred to Livingston, Mont., as general foreman in December, 1902, and later was made master mechanic of the Yellowstone divi-

A. W. Wheatley

sion, with headquarters at Glendive, Mont. In June, 1903, he was appointed shop superintendent at Brainerd, becoming in April, 1904, general master mechanic of the entire Northern Pacific system. In February, 1905, he accepted a position on the Rock Island as shop superintendent at Moline, Ill., leaving one year later to become assistant superintendent of motive power of the Union Pacific, with headquarters at Omaha. In June, 1907, he left railway service and entered the employ of the American Locomotive Company at Schenectady as general inspector. In December of the same year he was transferred to Montreal as manager of the Montreal Locomotive Works. In November, 1910, he was placed in charge of the Dunkirk plant, but in June, 1911, left to accept the position of vice-president and general manager of the Canadian Locomotive Company, Ltd.

The Locomotive Feed Water Heater Company, 30 Church street, New York, has been organized with a capital stock of $1,000,000 and with the following incorporators: George M. Basford, Samuel G. Allen, E. A. Averill, H. F. Ball, Luther D. Lovekin, Joel S. Coffin, LeGrand Parish, J. E. Muhlfeld, George L. Bourne and V. Z. Caracristi. This company will develop and handle for locomotive use the film heater designed and patented by Luther D. Lovekin, chief engineer of the New York Ship Building Company. The officers of the company are: President, George M. Basford; vice-president, E. A. Averill. Mr. Basford will also form the G. M. Basford Company to handle the advertising accounts of a number of railway supply concerns.

George M. Basford is now chief engineer of the railroad department of Joseph T. Ryerson & Son and will sever his connection with that company on March 15 to take up his new work. Mr. Basford was born in Boston in 1865, where he attended the public schools. He was graduated from the Massachusetts Institute of Technology in 1889, after which he entered the Charlestown shops of the Boston & Maine, later going to the Chicago, Burlington & Quincy as a draftsman at Aurora, Ill. He left the Burlington to take a position in the motive power department of the Union Pacific and was connected with the test department of that road for some time, after which he entered the service of the Chicago, Milwaukee & St. Paul as signal engineer. Later he was superintendent of construction of the Johnson Railway Signal Company, was with the Union Switch & Signal Company for a short time, and then became signal engineer of the Hall Signal Company. In 1895 he became mechanical department editor of the Railway and Engineering Review, and in 1897 was made editor of the *American Engineer and Railroad Journal* when that publication was owned by R. M. Van Arsdale. In September, 1905, he was made assistant to the president of the American Locomotive Company and in March, 1913, became chief engineer of the railroad department of Joseph T. Ryerson & Son.

G. M. Basford

Mr. Basford was one of the founders of the Railway Signal Association and has been known as the father of that organization. He has been closely identified with the development of the locomotive in this country and is also noted because of the inspiration and assistance which he has given not only in developing rational apprenticeship courses for mechanics in the motive power department, but in the efforts which he has made to awaken railway officers generally to the necessity for giving more attention to the selection, training and promotion of employees. His work with the American Locomotive Company was notable among other things for the development of the publicity campaign of that company which has been an important factor in awakening railway supply manufacturers to the possibilities of advertising. During the early stages of the development of the Railway Business Association in the winter of 1908-9 arrangements were made with the American Locomotive Company whereby Mr. Basford gave part of his time to that association as secretary. A more complete sketch of Mr. Basford's career will be found in the *American Engineer* of April, 1913, page 225.

E. A. Averill was born at Richland, N. Y., August 13, 1878, and after a preparatory education in public and private schools entered Cornell University in 1896. He was graduated in 1900 with the degree of mechanical engineer and specialized in railway mechanical engineering during his senior year. The summer of 1899 he spent in the shops of the Philadelphia & Reading, Reading, Pa., and after graduation went into the shops of the Chicago, Burlington & Quincy at West Burlington, Iowa. After four years' service with the Burlington, the greater part of which was spent in shop and roundhouse work and on the road, Mr. Averill joined the staff of the Railway and Engineering Review of Chicago. On January 1, 1906, he joined the editorial staff of the *American Engineer and Railroad Journal,* and on April 1, 1910, became managing editor of that publication. On March 1, 1914, he was made engineer of operation of the Standard Stoker Company, with which company he has been connected until recently.

E. A. Averill

George L. Wall, vice-president and manager of the Lima Locomotive Corporation, has resigned and taken an office at room 219, Opera House block, Lima, Ohio.

H. K. Porter, formerly southern sales agent with office at Atlanta, Ga., for the U. S. Metal & Manufacturing Company, of New York, has accepted a position with the Hyatt Roller Bearing Company, of Newark, N. J.

Watson H. Linburg, president of the United & Globe Rubber Manufacturing Companies, Trenton, N. J., died on January 6. Mr. Linburg was one of the pioneers in the manufacture of air-brake hose and other mechanical rubber goods used by the railroads.

Frank Snyder, general superintendent of the Mt. Vernon Car Manufacturing Company, Mt. Vernon, Ill., died at his home in that city on Wednesday, February 2, after an illness of about ten days. Mr. Snyder had been general superintendent of the company ever since its organization 26 years ago.

The American Car & Ship Hardware Manufacturing Company, New Castle, Pa., has changed its name to the Johnson Bronze Company. The change in name has been made solely for the convenience of the company's customers; there will be no change in the policy or personnel of the company. The

officers of the Johnson Bronze Company are C. H. Johnson, president; T. H. Hartman, secretary and treasurer, and P. J. Flaherty, general manager.

Samuel G. Allen has been elected president of the Franklin Railway Supply Company, New York, and Joel S. Coffin, formerly president, is now chairman of the board. Mr. Allen has served as vice-president since the incorporation of the company. He was born in 1870 at Warren, Pa., and was educated there and at the Pennsylvania State College. He was plunged into business responsibilities immediately after leaving college, but nevertheless found time to study law during a period of intense business activity. He was admitted to the bar in Warren county, Pa., and practiced law for nine years. In 1901 the Franklin Railway Supply Company was formed, with Mr. Coffin as president and Mr. Allen as vice-president. The ability of Mr. Allen as a lawyer and as a business man is reflected in the success of the large number of companies with which he is connected as an officer and director.


S. G. Allen

Frederick Heber Eaton, president of the American Car & Foundry Company and chairman of its executive committee since June, 1901, died at his residence in New York City, January 28. Mr. Eaton had been a commanding figure in the car manufacturing industry for many years. He was born at Berwick, Pa., April 15, 1863. He obtained his early business experience as chief clerk in the office of the Berwick Rolling Mill Company, then a subsidiary of the old Jackson & Woodin Manufacturing Company. From 1892 to 1899 he was successively secretary, vice-president and president of the Jackson & Woodin Company at Berwick. In 1899 he was an important factor in the formation of the American Car & Foundry Company and was chosen for the position of first vice-president. In June, 1901, he succeeded to the presidency and to the chairmanship of the executive committee, which office he continuously held until his death on January 28. Mr. Eaton was also chairman of the board of the American Car & Foundry Export Company.


F. H. Eaton

Charles A. Liddle, newly elected vice-president, and D. A. Crawford, newly elected treasurer of the Haskell & Barker Car Company, have also been elected directors of the company.

Patrick J. Carroll, president of the Bucyrus Steel Castings Company, the Ohio Locomotive Crane Company and the Carroll Foundry & Machine Company, Bucyrus, Ohio, died on January 20 at the age of 55 years.

F. V. Roy, heretofore manager of the railway supplies department of Fairbanks, Morse & Co., Chicago, has been appointed manager of the company's Omaha house. E. E. Pendray, heretofore representing the company in Texas territory, has been appointed manager of the railway supplies department, with headquarters at St. Louis. C. N. Wilson, representative on the St. Louis lines, has been transferred to the Texas territory, with headquarters at Houston, Tex.

B. B. Jones, of Oklahoma City, Okla., formerly with the Illinois Central at McComb, Miss., has been elected president of the O'Malley-Beare Valve Company, Railway Exchange, Chicago, succeeding R. L. Beare. The following men have been added to the sales force of the company: W. M Leighton, formerly with the Paxton & Mitchell Company, Omaha, Neb.; H. M. Newell, formerly with the H. W. Johns-Manville Company; Blake C. Hooper, formerly with the Grip Nut Company, and J. N. Gallagher, formerly foreman of the boiler shops of the Illinois Central at Birmingham, Ala.

Henry Lee, secretary and treasurer of the Simmons-Boardman Publishing Company, publishers of the Railway Age Gazette, the *Railway Mechanical Engineer,* the Railway Signal Engineer and the Railway Electrical Engineer, has been elected a vice-president. Mr. Lee's entire business career has been spent with the Railway Age Gazette and The Railway Age. He was born at Hamlet, Ill., on May 25, 1884, and was educated in the common schools at Hamlet, and the high school at Aledo, Ill. In 1905, he graduated from a business college in Chicago, and on June 6 of that year joined the staff of The Railway Age as assistant to the business manager. In December, 1906, he was assigned to the news staff, and in September of the following year became an associate editor and was transferred to New York. When, in June, 1908, the Railroad Gazette and The Railway Age were consolidated and became the Railway Age Gazette, he was transferred back to Chicago, but in April, 1909, he returned to New York, where he entered the business department and was placed in charge of the advertising make-up desk. About November, 1909, he was given charge of writing advertising copy, and thus founded the copy-service department of the publication. He was shortly afterwards made one of the paper's representatives in the trade, and in March, 1910, was made secretary. In February, 1911, he was also elected treasurer and in June, 1912, became a director. Mr. Lee has taken an active part in the publishers' organizations devoted to technical and trade papers. In 1911-12 he was secretary and treasurer of the Federation of Trade Press Associations of the United States, and in January of this year was elected secretary of the New York Trade Press Association. As vice-president of the Simmons-Boardman Publishing Company he will also continue as treasurer of the company.


Henry Lee

CATALOGUES

Sand Blasts.—Bulletin No. 531, recently issued by the Pangborn Corporation, Hagerstown, Md., is a leaflet illustrating and describing the company's type "L. A." rotary table sand blast.

Engines and Pumps for Oil.—Bulletin No. 9, recently issued by the National Transit Pipe & Machine Company, Oil City, Pa., is devoted to the company's foam system for extinguishing oil fires.

Pipe.—The American Spiral Pipe Works, Chicago, has issued Bulletin 15-9, descriptive of its line of lap welded pipe. The booklet contains a large number of views of pipe supplied for various installations.

Pneumatic Tools.—The Chicago Pneumatic Tool Company has recently issued Bulletin No. 34-K relative to the class N-SO fuel oil driven compressors and their application to the unit system of air power plants.

Machine Tools.—Bulletin No. 1013 recently issued by the Reliance Electric & Engineering Company, Cleveland, Ohio, gives a description and specifications of the Reliance type ASL, form A all-gear motor drive for application to cone-pulley lathes.

Turbines.—"The Terry Turbine" is the title of a new bulletin just issued by the Terry Steam Turbine Company, Hartford, Conn., giving a general description of the various turbine applications, and dealing particularly with various kinds of high, low and mixed pressure turbines.

A Railway Crane.—The Bucyrus Company, South Milwaukee, Wis., has issued an eight-page pamphlet, describing its Class 150-17 crane for wrecking and other railway purposes. This pamphlet gives the details of its construction and operation and is illustrated with numerous photographs.

Machine Tools.—The Covington Machine Company, Covington, Va., has recently issued bulletin No. 11, containing a number of illustrations of Covington punches, shears, bending rolls, etc., for all classes of service. The sole agent in the United States for these machines is Manning, Maxwell & Moore, Inc.,New York.

Power Hammers.—A booklet recently issued by Beaudry & Co., Inc., Boston, Mass., describes and illustrates the company's line of Champion and Peerless power hammers. The various types of hammers are described in some detail and information is given concerning the kind of work for which each hammer is best fitted.

Bulb Sections.—The Carnegie Steel Company, Pittsburgh, has issued a pamphlet containing tables and data on all the sections which they now roll in bulb angles and bulb beams. This is in response to an increased demand for this class of material for use in steel car construction, and particularly for steel ship building in the United States and elsewhere.

Portable Acetylene Lights.—The Alexander Milburn Company, Baltimore, Md., has recently issued a 52-page booklet describing and illustrating its line of Milburn lights for all kinds of service. The booklet explains for what service each light is intended, shows typical illustrations, explains the construction, and shows the methods of operating the lights. Several pages are devoted to letters from railways and other companies who have used the lights and have found them of value.

Pipe Specialties.—The National Tube Company is issuing a very attractive booklet entitled: The Whole "Kewanee" Family. The booklet in its 72 pages illustrates and describes the Kewanee union (the "father" of the family) in its various forms, and the other Kewanee specialties such as the N. T. C. regrinding valves, National service cocks, etc. On page 60 there is a complete list of the Kewanee specialties, and on pages 39 to 47 are given instances of satisfactory uses of Kewanee unions and specialties.

Filing Cabinets.—The Yawman & Erbe Manufacturing Company, Rochester, N. Y., has recently issued a booklet entitled "The Proper Place for Blue-Prints and Drawings" emphasizing the necessity for adequate filing systems for the drafting room and detailing the advantages of the Mammoth Vertical File made by the company for blue-prints and other drawings.

Locomotives.—Bulletin No. 1, recently issued by the Lima Locomotive Corporation, contains illustrations and general descriptions of a number of locomotives which the company has built for representative railroads. Included are the Erie, Pacific, Mikado and six-wheel switching locomotives, a Duluth & Iron Range Mikado locomotive, a Pennsylvania Lines West six-wheel switching locomotive, a Lackawanna eight-wheel switching locomotive and others.

Acetylene.—The Searchlight Company, Chicago, has issued a pamphlet entitled "The Searchlight Treatise on Acetylene." It contains 12 pages, briefly describing the development of the use of the oxyacetylene process for welding and cutting, and discusses at some length the commercializing of the gases, in which the method of preparing, purifying and handling acetylene in cylinders is considered. There is also a brief discussion regarding the use of acetylene generated by small generators at the plant vs. the cylinder acetylene.

Rotary Planing Machine.—The Newton Machine Tool Works, Philadelphia, Pa., have recently issued Catalogue No. 50, describing their rotary planing machines or girder ending and facing machines. The catalogue gives a general description of these machines, together with a copy of the general specifications, including illustrations of the various types with their general dimensions. Various other illustrations are included which show the Newton rotary planing machines installed in various shops throughout the country.

Threading Machinery.—The 1916 catalogue of the Landis Machine Company, Inc., Waynesboro, Pa., catalogue No. 22, illustrates in its seventy-eight pages, the line of threading machinery made by the company. The booklet contains some exceptionally good photographs of the various kinds of bolt threading, bolt pointing, nut tapping, pipe threading and cutting machines, screw cutting die heads, chaser grinders, etc., and there are also given specifications, list prices, code words, etc., as well as descriptions of the machines and information as to the kind of work for which each is best adapted.

Weighing Coal and Water in Power Plants.—Bulletin No. 101 of the Richardson Scale Company, Passaic, N. J., issued under date of January, 1916, bears the title "Automatic Weighing of Coal and Water in Power Plants." The book, which is attractively illustrated and well printed, emphasizes the advantages of weighing coal and water automatically in power plants, and aims to show, with the aid of half-tones and line drawings, the excellencies of the equipment which this company makes for this purpose. The scales are described in detail, and a large number of the illustrations show typical installations.

Cork Insulation.—The Armstrong Cork & Insulation Company, Pittsburgh, Pa., has issued a 152-page book, describing its Nonpareil corkboard insulation. This book, which is prepared in an attractive manner, describes briefly the preparation of cork and more in detail the merits of this material for different purposes and tests to which it has been subjected. Nearly one-half the book is devoted to specifications covering the methods of erecting Nonpareil corkboard for a wide variety of conditions. The book is well illustrated with photographs of typical installations of this material.